SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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FRIDAY, FEBRUARY 6, 1903.

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THE RISE AND PROGRESS OF ECOLOGY.[*]

THE extraordinary development of botanical science during the last decade, in which so much hitherto unknown has passed so rapidly into history, fully justifies the usual review of progress at our great annual gatherings. In following this time-honored custom I have ventured to extend the retrospect far enough to contrast some of the aspects of present-day botany with an earlier condition of the science, familiar to a few of us, though known to most of you only by tradition. The outlook, which has also come to be expected, will be limited to a single branch of the science, which has shown remarkable vigor, but the future of which is regarded by some as problematical. The reminiscences will naturally come first.

Twenty-five years ago, in one of our northern universities, a young instructor with a single assistant was engaged in the rather comprehensive task of teaching botany and 'biology.' The botany consisted in part in the analysis of flowering plants by means of Gray's 'Manual,' and in studying the minute anatomy of leaves, stems and other parts of plants, which the literary students pursued under the name of structural botany, while, with a strong

[*] Presidential address delivered at the Washington meeting of the Society for Plant Morphology and Physiology, December 30, 1902.

flavor of crude drugs, it was administered to the pharmacy class engaged in the study of adulterants. Then, too, there was the so-called cryptogamic botany, and, finally, the general biology, after Huxley and Martin, in which the steps of evolution from protococcus to frog were succinctly unfolded. None of the instructor's colleagues had the slightest suspicion of what it was all about, and the students—well they learned some things in spite of their environment and the teaching they got.

As for the books used—the *Centralblatt* was not in existence, but this mattered little, for neither was the enormous literature it has since recorded. The *Botanische Zeitung* was regularly published, but the library committee had no use for it, and much the same was true of most of the periodicals that every working botanist now finds indispensable; but we had Sachs's 'Text-book of Botany' and the big picture-book of LeMaout and Decaisne, and on the shelves were Sullivant's 'Icones Muscorum,' and dear old Berkeley, and Cooke's 'British Fungi,' with all their impossibilities, and last, but not least, the reports of the government microscopist, of which we can not speak particularly.

The rest of the outfit was in keeping. Microscopes, of a certain sort, there were, but no other apparatus whatever. Razors were sharpened on a well-hacked strap, iodine and sulphuric acid constituted the reagents, and the enthusiasm of fellow adventurers in an unknown country kept up the courage of young men and women who walked by faith and saw but little.

All these untoward conditions harmonized with the stage of development of the science itself. In this country there were only the laboratories of Harvard that had anything to attract special students in botany, and abroad even the laboratories at Leipzig and Bonn had little to offer compared with the magnificent work now associated with the names of Pfeffer and Strasburger; in vegetable pathology the simple methods of DeBary and Brefeld, though coupled with infinite patience and some remarkable results, gave little promise of what has since been achieved. In continental laboratories, for the most part, developmental history began with the *punctum vegetationis* instead of the egg cell. Anatomy was largely a matter of fibro-vascular bundles, and the literature of mitosis was unwritten. In short, botany, as we know it to-day, was as yet only a potentiality.

The men, too, who represented the science in America, how few they were and how isolated. There were Gray and Watson, Eaton, Austin, Prentiss, Engelmann and a very short list of botanists contemporary with them who are still at work. We seldom saw one another, and we had no dreams of gatherings like these, at which the working botanists of the country are numbered by scores, too many already comfortably to hear one another talk.

Now all is changed. With the coming in of the new century the multiplied volumes of the *Centralblatt* and the *Jahresbericht* tell the story of an unequaled productiveness, and a literature which, as measured by number of periodicals, now considerably outranks that of any other science whatever.

And this literature is, much of it, widely different from that of the earlier days. Without essaying the heroic task of reviewing even the main lines of progress, I wish in passing to recall with you certain very significant changes that are taking place. First in systematic botany. You are familiar with the fact that, as the result of observations extending through some seventeen years, De Vries has recorded the actual origin of various species

of plants, 'evolved,' as he puts it, 'with a sudden leap,' not as a result of selection or the struggle for existence. It would seem that, for the species reported, the case is well within the line of positive demonstration, and that some species, at all events, arise by mutation. It is not clear that all species originate in that way, but meantime the whole question of the origin of species is thus coming more and more within the domain of direct observation. Henceforth, positive results are to be attained not by guessing, but by cultivation, and it is an inestimable gain to the science that the issue is thus clearly defined. Students who have been diverted from systematic botany because of its guess-work and its unspeakable nomenclature, have in this new way of species-making a goal worthy of attainment. It is a method that promises definite and final results in a field where hitherto 'judgment' and speculation have unfortunately, though perhaps inevitably, held sway.

The closely related field of experimental morphology, altogether unknown in earlier days, is also making a place for itself in botanical literature. The laboratory study of plastic forms has not thus far presented fully satisfactory evidence of the permanence of forms thus easily evoked, but even if no student of experimental morphology has yet produced a species demonstrably permanent, the accumulation of evidence is pointing more and more clearly to the persistence of character acquired in response to changes of environment. Thus are we coming, as it seems, to conclude that Lamarck, Darwin and De Vries have all, in their own way, gained some insight into the origin of specific characters, but that nature in the beginning took counsel of none of them, and is still working in devious though consistent ways, producing species at her pleasure, meantime laughing at our theories and our narrow range of vision.

In the matter of life histories our literature is beginning to show the inevitable breaking with the past. It has always been interesting, no doubt, to know in how many planes a new series of cell walls are formed, and at what angles and with what indication of relationship to this or that 'type,' but it is certainly encouraging to note the present tendency to ask how constant these phenomena are and what their variations under changed conditions signify.

The time is too short to speak of the phenomenal development of plant physiology since the working days of Sachs, which to a few of us seem not long ago, and of plant pathology in which we have had triumphant demonstration of what scientific spirit and method in America, now happily no longer unknown to European botanists, can accomplish. I hasten to that part of our science that is the last to make for itself a name, though it has long had a place in botanical labor and literature, namely, ecology. It has at the present time a mixed multitude of adherents, and with the double burden of a popular fad and oftentimes the cold shoulder of those who sit in judgment, if there is a survival of the name and the work it stands for, it will be because of its own inherent vitality and fitness, not because of the patronage it has received. Let us pass in review the history of this new name and what it stands for.

It is unnecessary to reproduce or even to condense the erudite etymological discussion carried on in SCIENCE a few months ago, with which, presumably, you are familiar. The word ecology has come to stay. Personally, I should have preferred bionomics, which has the advantage of indicating in its composition that living

things are its subject-matter. This latter term is at all events an acceptable synonym, and as such may properly be used as occasion requires. The question of a name, therefore, is settled and may be dismissed.

Not so, however, with the subject-matter, which represents a growth from many and various sources. The field of bionomics, in one department or another, has been successfully cultivated by Darwin, Warming, Schimper, Kerner v. Marilaun, Bonnier, Engler, Drude, Schwendener, Haberlandt and their co-workers in the Old World, not to enumerate a growing list in the United States. Some of these are known chiefly through their ecological work, others have conducted such work incidentally. In any case these names—not unworthy ones—represent ecology in their publications, much as De Bary, Sachs and Gray, for example, represent primarily morphology, physiology and systematic botany. We may, then, from their own work, better than from definition, form our conception of the subject.

To begin, as we must, with Darwin, every one knows that he was not a systematic botanist; he sent his plants away to have scientific names attached to them. Nor was he a physiologist; at any rate this was the judgment of Sachs, who ought to know. Nor yet was he expert as a plant morphologist; witness his chapter on the morphology of orchids; but he was the great exponent of ecology as it was taking form during the period of his active work and before it had a name. He, more than any other man before or since, worked in such sympathy with living things—not dried in the herbarium, nor tortured on the klinostat, nor pickled in formalin, but living, living in their own way—that they unfolded to him secrets they would tell no other, because he could understand.

The modern criticism of ecological studies seems to involve the implication that final results are only to be attained by experiment; that observation and induction are well enough, but that a plant will never tell its story correctly until it is brought to the rack. But, as a matter of fact, Darwin concerned himself chiefly with plants and animals as he found them. The record of his work is a record primarily of observation. He studied the shapes of flowers as the bees left them. Following the simple operations of the horticulturist, he observed through many generations the effects of cross- and self-fertilization. Such experiments as he performed were largely out of doors, simple or even crude, and had no part nor lot with the refinements of modern physiology. His work from beginning to end was dominated by this one great thought. He would know something of the origin of living forms as we find them. He would formulate a law not so much to express a present reaction as a habit and a history, and while aiming at the elucidation of the great problem he had set for himself, he was engaged, first and last, in studying the origin of adaptations, the study that constitutes ecology.

But there have been new phases and developments that have greatly extended the horizon of ecological study and in various respects changed its immediate object. Consider, for example, plant anatomy as De Bary left it and as it is now pursued. Dusting the volume and glancing through De Bary's great work with its treatment of primary and secondary growth, equivalent and non-equivalent members, anomalous thickenings, and more of life nature, whatever of wearied admiration may be stirred by this monumental record of indefatigable patience, one can not help feeling that it is no longer a thing of the present day. But when there came the great illuminating

principle embodying the relation of structure to function and external factors, with what eagerness even the apparently most trivial fact was gathered and pondered, instead of with the dogged sense of duty which drove us through the old anatomy. Here were spirit and life. True the disciples of Schwendener and Haberlandt, led on by the fascination of the new thought, in more than one instance have run beyond their masters in facile interpretation, but can any one doubt that the science of botany has been permanently advanced by the enlightening inspiration of the 'Physiologische Pflanzenanatomie'?

Morphological studies are coming into the same category. The methods and conclusions of Goebel in the 'Organography' have been criticised, it is true, but it may be well to consider that morphology through such work, as has been well said, is no longer the history of an idealized type, but an account of form as correlated with function and environment. Is there any question that we have gained immeasurably by the change and that this great work has materially contributed to the more scientific view? Most suggestive are recent studies of the orientation of the plant egg and its ecological significance. Surely embryology is in a more hopeful position to-day because a few daring minds have ventured beyond the limits of pure morphology and the bounds of absolute proof, and have suggested relations that may require many years to finally establish.

Still another phase of ecological study, namely, plant distribution as developed by Warming, Schimper and others, has recently come into special prominence. It involves no less than an attempt to account for the present actual distribution and association of plants, through historical and present agencies, and the response of the living organism to its surroundings. More perhaps than any other branch of biological investigation, it calls for the most varied and thorough preparation. There must be a ready knowledge of systematic botany as a working tool, at least good general training in physiology, correct morphological conceptions, and a practical knowledge of physiography. All of these added to sound judgment and conservative habits of thought are essential prerequisites to the successful study of this subject as it is now taking form.

It may be asked whether this branch of science has within itself enough to warrant such preparation and the devotion with which it is pursued by no small number of the rising generation of botanists. There can be, it seems to me, but one reply. If the labors of geologists in bringing to light, piecemeal and often with more or less uncertainty, the past history of the earth is warranted—as it is a thousandfold, whether the progress of science or industrial achievement is considered—then the critical study of this last phase of geological history, a phase which no living geologist is prepared to work out alone, fully justifies the most efficient and persistent effort that botanists trained in the manner indicated are capable of giving. Like the geologists, they are confronted with problems of peculiar intricacy, some of them no doubt insoluble, many that can never be settled in the quiet of the laboratory, others perhaps that can be settled nowhere else, all together involving work that must inevitably attract men who are more than botanists merely, who are willing to grapple with problems of many elements and more than one unknown quantity, and who know how to work patiently when results are both slow in coming and incomplete. Very few, indeed, have possessed, or are likely to possess, all these qualifications, yet some real progress has already

been made. Without attempting to review and estimate this, let us glance at some of the landmarks.

We owe to Warming, more than to any other, the conception now familiar to us under the name of plant society, which in Warming's conception included not merely a collection of plants living together, but, what the name expresses, an association of plants with mutual relations among themselves and common adaptations to their environment. The most conspicuous and useful result of Warming's work was to show so convincingly the predominant influence of water in determining plant societies that his classification, based on this as the chief factor, has been universally adopted, though, as he well knew, so simple a grouping could not serve as a permanent and complete system, however helpful it may have been in the early development of the subject.

Later the great work of Schimper brought us face to face with the tremendous difficulties to be met and overcome in attempting to account for some of the most familiar facts of distribution, but it has greatly broadened our conception of plant relations, presenting with almost the force of a new idea the fact that every plant on the surface of the globe grows where it does because conditions of air, light, temperature, water, soil and the behavior of other plants and animals—not merely in present time, but through an indefinite past, acting not alone but together, not on a lifeless thing, like clay in the hands of a potter, but on living, changing, adaptive beings—have made its presence possible. It is to such a complicated study and to problems so apparently hopeless of complete solution that the student of ecology to-day addresses himself, and it is well, perhaps, that here as in other departments of human activity, there are some daring souls who, for the very joy of treading new ground, do the work of the pioneer, without too close calculation of the probable reward.

If a personal reference may be permitted, I am glad to acknowledge my own great indebtedness to such pioneer work on the part of one of our own botanists. The study of the distribution of plants along shore at Lake of the Woods,* which appeared in 1897, has more than realized the hope of the writer that it 'might be of service in stimulating ecologic study of plants.' It could never have been written in the closet or the laboratory, however much of such labor is still required to verify or supplement the remarkable accumulation of observation and suggestion there recorded. The author has shown the practicability of tracing, here with reasonable certainty, there less perfectly, among most complicated relations, cause and effect.

If it is said that these results are too indefinite to be of scientific value, it may be answered that it is upon precisely such data that for many scores of years the practical operations of forestry have been conducted, and that on this distinctively ecological basis it has become one of the most exact industries of the age, standing perhaps next to life insurance in the certainty with which given results are attained. It is true that individual judgment is here an important factor, and allowance must be made for the personal equation, but this is also true in astronomy, one of the most exact sciences, and in perhaps every other department of human activity that is worth considering.

A still later large and increasing literature, represented by the monographs of Engler and Drude's 'Vegetation der Erde' and many other recent contributions of

* MacMillan, *Minnesota Botanical Studies*, I.

European and American botanists, is perhaps too strictly contemporary for unbiased judgment, but in any case the very mass and rapidity of its accumulation is highly significant. It is expressive of the fact that a large contingent of young and progressive botanists are reaching out far beyond the bounds of systematic botany on the one hand and the limitations of the laboratory on the other and are finding abundant opportunity for productive work.

Without at present referring to others of these more specifically, I gladly pause to do honor to the memory of the great man who, after some 'forty years of sojourn and wanderings' through the state of Alabama, presented three years ago his final contribution to the plant life of that state.* He was seldom seen in gatherings of botanists, and I have heard him lament his lack of training such as it is the fashion now to give, but he had more than the wisdom of the schools, and perhaps studied plant relations more effectually because of his comparative freedom from their traditions. Certain it is that his 'Plant Life of Alabama' has come to us as a noteworthy and acceptable contribution. Through his and similar labors, worthy, if time permitted, of special mention and discussion, the time is drawing nearer when we shall have the data for a satisfactory comparative study of the phytogeography of the whole world.

How shall such an end be attained and how can present methods be improved so as to hasten the desired consummation? Surely not, in the first place, by limiting or diverting into other directions the present output of phytogeographical contributions. All of this and much more is needed. The data for general conclusions are all too slow in coming in. This does not mean, however, that the scattering observations of every summer cruise, with half-baked notions of the 'reasons of things,' need be inflicted on the long-suffering readers of botanical literature.

There must be higher ideals, and only those who have studied, year after year, a limited area and have watched the successive changes that a few seasons bring can quite appreciate what patience and labor the maintenance of such ideals involves.

The accumulation and expression of facts as they really are should take, as it seems to me, nine tenths, possibly ninety-nine one hundredths, of the time that is being given to ecological work. Hypotheses are fascinating, but we have all erred, perhaps, in demanding that those who busy themselves with such observations shall show us promptly their bearing on a theory of the universe. At present it is really the main business of the ecological student to ascertain and record fully, definitely, perfectly and for all time the facts. He is not bound to tell us all their meaning, much as we would like to know; and furthermore, a fact once established is just as good a fact and just as likely to have an important bearing if it is ascertained in a field or garden, in the depths of the Dismal Swamp or in the Sahara, as in a university laboratory. It is just as well for science that Gregor Mendel was working out of doors forty years ago, perhaps even better than if he had known more fully the significance of his own work and had abandoned the field for the laboratory and the microscope. We need to honor more than we do the man who knows how to see living things without complicated apparatus, and we need, cheerfully and without apology to ourselves or others, to give full days of active toil to learning and telling *what is*. It is far more difficult—I speak from personal experience—after these years of laboratory supremacy, to

* Mohr, 'Plant Life of Alabama,' 'Cont. U. S. Nat. Herb.,' VI., 1901.

teach a student to critically report in decent English a direct observation in the field, than to secure from him a tabulated statement of artificially produced reactions.

And yet no true worker in science can go on with his daily task of accumulating data without at least attempting to answer to himself the insistent question 'What does it all mean?' We need and shall always need the thoughtful and original workers who give us not only 'facts well proved,' but also 'conclusions * * * deduced from facts well proved,' and we owe a debt even to those who have the insight sufficient to offer fruitful suggestion.

As a single example, may I refer to a recent paper by Paul Jaccard * in which, from a comparative statistical study of plant distribution in alpine regions, involving an enormous accumulation of data, some most interesting conclusions are drawn. It is shown that, while in the region studied there is an almost mathematical relation between number of species and variety of ecological conditions, the generic coefficient, or ratio of genera to species, is inversely proportional to such variety of conditions; that is to say, in the struggle for existence between the numerous species of a habitat, the species of one and the same genus are in great measure crowded out by species of different genera. Thus it is shown, 'in the course of a purely statistical study, that the struggle for existence works toward the elimination of like elements and selection of unlike, and that, furthermore, the resultant of a number of external factors operates as a selecting cause, not merely on the single species, but on the grouping of species, on the society.' In these studies then, the genus becomes 'a real ecological unity with a definite intrinsic value.'

Whether or not we accept the author's conclusions throughout, we are at all events indebted to him for an ecological study carried out with mathematical precision, from which some at least of the conclusions have been drawn with mathematical certainty. It is, to be sure, a question how far, at present, quantitative results can be looked for in this line of work, but he is not the highest type of scientific worker who demands to know at every step what he shall have for his pains. It is certain, I think, that by just such studies as those of Jaccard we shall be able through careful field work to designate and make increasingly accurate estimates of dominant factors. But many problems must necessarily be taken to the laboratory, and it is to such a union of field and laboratory work that we are to look for the rational development of ecological investigation. Ecology standing alone would present much the same anomaly as physiology getting on without physics and chemistry. But all things in their time. When one of our foremost ecologists declares that ecology must be brought more and more to a physiological basis, he states an obvious truth; it is also true, perhaps, that physiology should take rank as speedily as possible with the exact sciences and record its conclusions more and more in mathematical formulæ. These great consummations, however, are likely to require some little time, and meanwhile those of us who have not yet learned always to think in equations may, nevertheless, find much to do.

It is hardly necessary to call your attention to the need of a settled nomenclature, nor to the fact that we are likely to have a great deal more than we want when we get it. To speak plainly, it seems to the writer little short of scientific

* 'Gesetze der Pflanzenvertheilung in der alpinen Region,' 'Flora,' 90: 349–377, 1902.

crime to load upon willing workers a heavy burden of terminology. Far better than this, however desirable uniformity may be, in itself considered, would it be for each writer to employ, as far as possible, expressions and definitions already current in existing literature, and if forced by the nature of his work to introduce new ones, to do this as infrequently as possible.

It may be permitted to insist once more on the inclusiveness of the training indispensable to success. In phytogeography, to mention only one phase of the subject, the work must be done by the botanist rather than by the physical geographer, but nevertheless by a botanist who is sufficiently at home in physiography to read and understand what is written in the later pages of the physical development of the earth. Like the geologist he must have an instinct for following up a clue and reading history, often as dim and broken as that of some precious manuscript. He must have a conservative judgment, and yet he must freely employ hypotheses to be as freely abandoned or maintained as occasion requires. He must have the spirit of a bold explorer combined with the cautious temper of a trained investigator. He must be at home in the herbarium, but not choked by its stifling atmosphere; he must be a trained experimenter, but not near-sighted. He is aiming to see for himself and to transmit to others a faithful picture of the vegetation of the earth—or of that portion of it which he has studied—and to take account of the various factors that are responsible for what is to-day. He is a writer of history, and considering the broken record and the endless difficulties to be overcome, it must be admitted that the histories written by phytogeographers compare favorably with those that recount the rise and fall of empires.

To a student who has had this broad, thorough and deep training, and who has still a normal vision, there is an inspiring hope. If any fact is borne in upon us with the force of a demonstration, it is that at least in this corner of the universe in which we live we are certainly witnessing the slow but sure evolution of an eternal fitness of things, not realized as yet, but approaching its consummation. Misfits there are, but the exquisite adaptations we see have not always been as nearly perfect as they are to-day. Some day with more perfect adaptation, the ideal of science and the vision of prophecy will be fulfilled.

But workers in science in these days are rightly called upon to show that their work promises something besides the fulfillment of ideals. Modern science, favored as never before with the means of extension and development, should be able to justify its cost to the state by contributing to the betterment of human life. Tested by its capacity to meet this demand, ecology, I think, will not be found wanting. Agriculture, horticulture and forestry are, consciously or not, practical applications of its principles, and their best development has been attained where these principles have been most intelligently observed and applied. It is safe to predict for all these great industries a growth in our own country of which we can at present form but slight conception, and it is equally safe to say that as contributing to this development the study of ecology, now beginning to take definite and permanent form, will abundantly prove its necessity and value. It is unnecessary to remind you that the early dream of science of an exact analysis of the soil, followed by an adequate supply of lacking elements, resulting in fruitful harvests, has never yet been realized in general agriculture, nor can any such analysis, however complete, take the place of that knowledge of the plant itself, its

history, its habits and its needs, that now constitute so large a part of our study, and is an acknowledged factor in practical agriculture.

American horticulture, still more obviously a branch of applied ecology, has already reached a stage of development in which it is hardly an exaggeration to say that desired forms are actually made to order, and some of the men who are contributing to this end are leading promoters of ecological investigations. They are the men we summon when we want to know the real basis of Mendel's laws and the ones who are teaching us from their own studies the course of contemporaneous evolution.

I have already referred to forestry as illustrating the extent and definiteness of application of ecological principles in a great practical industry. It is highly important, particularly in the United States, that this relation should be well understood. We are confronted in many of our states with peculiarly difficult problems of reforestation. Land that has been the greatest source of wealth to the state is now a wilderness, practically worthless until it is clothed again with forests. How this is to be accomplished is one of the serious economic problems that the present generation is called upon to solve. We are gaining the data in part through the suggestions of professional foresters, but there is imperative need of all the light that can be gained by critical and extended study of the natural succession of plant societies. It is fortunate that such studies have already attracted earnest and capable students, and it is fair to say that those who desire to render the state a permanent economic service can hardly find a better field, providing they are fitted for the task.

I make no apology for thus emphasizing the practical value of this branch of scientific work. Service, first wrung from the unwilling slave, then the free-will offering of the citizen and patriot, is now the honorable goal of the worker in science, and there is no higher end to be attained.

Speaking for botanists, I have taken into account only one side of ecological study, that which relates to the habits and adaptations of plants. The habits of animals can not be less interesting and important, and it is a matter of congratulation that zoologists are entering this field with enthusiasm and well-defined aims. We extend to them our hearty greetings for the new year and the new era of biological work.

V. M. Spalding.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

SECTION D, MECHANICAL SCIENCE AND ENGINEERING.

TUESDAY MORNING, DECEMBER 30.

Electrical Engineering: J. Burkitt Webb, Stevens Institute, Hoboken, N. J.

Electrical engineering is a branch of engineering which more than any other joins the scientific with the practical, and bases the latter more immediately on theoretical considerations and mathematical calculations. It differs widely in this respect from some other branches of engineering, and for this reason papers which might otherwise come to this section are easily included under the head of physics, just as formerly all papers of scientific affinities went together into one section. Now, since Section D has been in existence, a paper, say, on thermodynamics, has been considered suitable for it, for although its matter was really a branch of physics, its engineering connections would naturally bring it to us. Now, Section B is overloaded with papers and I would suggest that some effort be made to get into this section such papers as may properly be claimed under

electrical engineering, interpreting it broadly if need be.

Stress: J. BURKITT WEBB, Stevens Institute, Hoboken, N. J.

Attention has often been called to the fact that in mechanics a confusion exists in the use of fundamental terms, which results in many cases from faulty definitions of the quantities employed.

Stress is one of the more recent terms, and a discussion of its meaning may lead to a better understanding of it.

An examination of authors shows that it is a general designation for tension, compression, shear, etc., in which authors agree; they differ, however, somewhat on minor points, so that the composite idea to be gained from a number of them is somewhat confused.

Its right to exist must depend upon its applicability to a definite thing in nature for which no better name exists, and we will attempt to show what this thing is.

When forces and moments are in equilibrium upon a material body, a state is produced therein which, viewed statically, is called a *stress,* and, viewed geometrically, a *strain.* Thus, if two equal and opposite forces of m pounds each, or, as we may express it, two forces m and $-m$ in the same line of action, be applied to the ends of a rope, a state of tension ensues therein. This is evident statically from its tendency to contract, and geometrically from its greater than normal length.

The following distinct points are to be noticed:

(*a*) It requires *two* equal and opposite forces to produce a tension, that is, it requires a 'couple,' and the definition of stress should be consistent therewith and with the following general conceptions:

A definite force applied at any point of a free body produces in one second a definite velocity of translation of its center of gravity. If a 'couple' of forces be applied, each neutralizes the translation of the other so that the center of gravity is unaffected. The forces of the 'couple' have, of course, parallel lines of action whose distance apart is the lever arm of the 'couple,' and the product of one of the forces by the lever arm is the moment, or torque, of the 'couple.' A definite torque produces a definite angular velocity, and may be neutralized by an equal and opposite torque so as to leave the body unaffected as to both translation and rotation. It is unscientific to exclude, as some authors do, from their definition of a 'couple' the case when the lever arm is zero; the 'couple' exists then as much as it ever does.

But besides these kinematic effects, which may or may not be produced, we have the static effect on the body itself, and a body can not act as the medium for balancing forces or moments without assuming a state of stress, so that a 'couple,' whose dynamic effect is reduced to zero by reducing to zero its lever arm, still causes *stress* in the body. In a 'couple,' therefore, the *essential property* of the forces themselves is neutralized, and the dynamic or static properties of the couple alone remain.

A stress, therefore, is *not* a force, any more than a 'couple' is, although appropriately measured in pounds or similar unit used for forces.

(*b*) Another point of difference between a stress and a force is that a force is a vector having direction, while a stress has only a line of action. This is the more evident when we consider that changing the algebraic sign of a force reverses its direction, and that to produce one stress, say a tension, we require both the plus and minus forces, thus interfering with the idea of direction. A stress has only a line of action, and changing from plus to minus has nothing to do with direction, but means

the change from tension to compression, which corresponds with a reversal of the signs of the forces producing the stress. A plus stress being tension, a minus stress is compression, with no change in the line of action.

(*c*) A stress may or may not be considered per unit of area. There is nothing in a stress to make it different from a force in that respect. All forces are actually distributed forces, and all stresses distributed stresses. A stress must be defined as to its inherent nature, and not as to a method of measuring it. Sometimes 'total stress' is required, and sometimes the 'intensity' of the stress, or stress per unit of area, just as we speak of weight or weight per cubic or square foot. That is, we may wish to speak of the tension in a beam or the tension per square inch.

An examination of authors shows the justice of these three points, although I am not aware that they have been distinctly and positively affirmed, and the importance pointed out of making them clear in defining the word stress.

A Systematic Method of Calculating the Dimensions of Dynamo-Electric Machines: Carl Kinsley, University of Chicago, Chicago, Ill.

The dimensions are so arranged that a set of three simultaneous equations give the relations existing between the diameter of the armature, its length and the number of conductors in the winding.

These equations are primarily made to depend upon considerations which will determine the satisfactory operation of the dynamo. The *first* equation is made to depend on the electromotive force desired. The *second* equation considers the rise in temperature allowable. The *third* equation determines the efficiency of the machine.

The intermediate assumptions, such as the area covered by the pole piece, affect the ultimate dimensions, but all unite in giving the essential features desired, namely, the electromotive force, rise of temperature and efficiency.

Exhibit of a New Mechanical and Metallurgical Product: C. A. Waldo, Purdue University, Lafayette, Ind.

The new product was shown in two forms. A thin spherical shell two and one half inches in diameter, with a hole one eighth inch in diameter through it, and a reproduction in thin sheet copper of a common quart whiskey bottle. Both products had neither seam nor weld and were not made by electro-deposition. This is accomplished by a new process not yet made public.

Comparative Ductility of Steel under Gradual and Impact Loading: W. K. Hatt, Washington, D. C.

This note describes the results of tests to determine the effect of rapidity of deformation in tension on the ductility of steel. Bars were tested: (1) Under a gradual loading of about ten minutes' duration, and (2) under one blow of a falling weight, causing rupture in from .01 to .05 of a second. The tests cover a range of steel from soft steel castings and boiler steel to hard tire steel. The material was all of good quality.

It is evident from the results that an increased ductility may be expected under impact conditions in the case of soft steel. There seems to be a tendency under impact to develop nodes of ductility in tension bars, and sometimes two or even three distinct necks are formed. This may account for the observed increase in ductility. The phenomenon may be explained by the assumption that the harder portions of the bar transmit the shock quickly, throughout the region that they occupy, to the softer

parts where the shock is absorbed in producing deformation. The effect of low temperatures, for instance, is to elevate the elastic limit of steel, *i. e.*, to convert it, from the mechanical standpoint, into a harder steel; and when a bar that is partly frozen is broken in tension the frozen section suffers but little deformation under impact, while the other segments are stretched to the point of plasticity.

In case of harder steels, the indications are not so evident. It is difficult to obtain two bars cast from the same heat of steel that are of the same grain, and comparisons of individual bars are apt to be misleading. In general it may be said that the ductility under impact of hard steels may fall below that under gradual tests depending on influences not understood. There are differences of ductility under impact not detected by the gradual test.

Nicking the surface of a bar renders it less ductile under an impact test than under a gradual test. The shape of the cross-section and condition of surface have a minor influence. In the case of both hard and soft steels the ductility is greater when the bar is broken by a number of blows than when broken with one blow. Within ordinary limits the speed of delivery of a given amount of energy at one blow has no appreciable effect on the ductility. Low temperatures decrease the ductility more decidedly under impact than under gradual loading.

Cementation of Road Material and Elasticity of Clays: ALLERTON S. CUSHMAN, Bryn Mawr College, Bryn Mawr, Pa.

The method of testing the binding or cementing power of road materials was briefly described. It was pointed out that the cementing value was a phenomenon of the same nature as the plasticity of clays. Results obtained in the road material laboratory of the Department of Agriculture, seem to point to the fact that plasticity is dependent on a colloid condition of the particles. No sample has ever been met with that exhibited plasticity that did not contain water of combination, although many samples which contain water of combination do not exhibit plasticity. Only one sort of water of combination (the so-called Micellian water of Nageli and Van Bemmelen) is in any way a measure of plasticity. The inorganic colloids or so-called 'hydrogels' have been studied by Van Bemmelen. They are chiefly characterized by the peculiar structural relation they bear to water. They can be hydrated and rehydrated indefinitely unless by heating to too high a temperature the colloid structure is destroyed. Exactly the same phenomenon characterizes plastic clays and rock powders. The surfaces of roads are continually being powdered by the effect of traffic wear and weathering, and the particles are continually being cemented and recemented. If the material of the road lack plasticity the particles blow and wash away too rapidly. The binding quality of such rocks as limestones and dolomites is a function of the hydrogel impurities present usually either in the form of silicic acid or hydrated oxide of iron.

Topographical Work, U. S. Geological Survey: H. M. WILSON, Washington, D. C.

A verbal description of recent topographic work done by the U. S. Geological Survey, the extent of the same as far as completed being shown upon a map of the United States.

TUESDAY EVENING, DECEMBER 30.

Construction of Washington Monument and Library of Congress: BERNARD R. GREEN, Washington, D. C.

A description of the construction of the

monument, illustrated by a series of photographs.

Rapid Primary Triangulation: John F. Hayford, Washington, D. C.

This paper is a statement of the results secured by a triangulation party on the 98th meridian triangulation in Kansas, Oklahoma, Indian Territory and Texas, during the season of 1902, and of the peculiarities of their methods. This triangulation is fully up to the primary standard degree of accuracy, and it is believed to be the most economical as well as the most rapid triangulation of its class yet executed.

Reaction versus Velocity as an Active Agent in Removing Bars: Lewis M. Haupt, Philadelphia, Pa.

Necessity for channels of larger capacity across ocean bars, to keep pace with the growth of vessels and commercial demands. Present resources of the engineer limited to concentration and dredging. Defects of this system, with illustrations.

Reaction, the cause of deep holes and channels, rather than mean velocities. Eddies which scour and those which deposit. Applications of reaction, as exemplified in nature, to effect similar results locally across ocean bars, illustrated. Great economy and efficiency of the single-reaction breakwater as compared with other methods in vogue.

WEDNESDAY MORNING, DECEMBER 31.

Notes on Comparative Designs of Metallic Arch Bridges: H. S. Jacoby, Cornell University, Ithaca, N. Y.

A comparison of the weights of three-hinged spandrel-braced arches for different heights of the crown hinge, ranging from the bottom to the top chords. The effect of variations in bridge specifications upon the weights of two-hinged arch ribs and spandrel-braced arches. The effect of different curves for the lower chord.

Road Material Laboratory: L. W. Page, Washington, D. C.

This paper describes different road-making materials and points out the wisdom of having them tested by laboratory methods before they are used in construction. The amount of traffic on one road may not require the same kind of material that another road should receive. The binding materials present with crushed rocks of various kinds have much to do with their value for surfacing roads. The road-material laboratory of the Agricultural Department makes these tests free and invites an inspection of the equipment and methods used in the examination of road material.

Agricultural Engineering: Elwood Mead, Washington, D. C.

Conditions of farm life and farm labor in the United States have undergone a revolution in the past fifty years. The shorter hours of labor and conditions of life in factories are having their influence on farm work. The farmer is compelled to do as the factories have done, substitute power for hand labor and use the most effective implements and machines. Application of power to farm work is taking new and significant form through the use of steam, gas and electricity as substitutes for animal power. Increasing importance of this evolution has attracted the attention of European countries, where institutions for the study and improvement of farm machinery are supported by the state.

The agricultural colleges of this country have in recent years given serious attention to this subject. A committee on methods of teaching agriculture has formulated a course in the subject which has been published in Bulletin 45, on pages 6 and 7, of the Office of Experiment Stations. One difficulty confronting the colleges is the lack of classified and verified information.

The interest shown in this subject shows that the time is ripe for further action.

The Mechanical Problems of a New Ore-producing Territory: C. A. WALDO, Purdue University, Lafayette, Ind.

A recently discovered copper and silver district in the Pan-Handle of Oklahoma is thirty miles distant from railroad transportation. The problem is to secure power to concentrate the ore at the mine. Electric power generated by the water of a stream twenty miles distant may be used, or gas engines adapted to the use of Texas oil may be more practicable.

The Metric System: J. BURKITT WEBB, Stevens Institute, Hoboken, N. J.

The advocates of the metrical system are pushing it more than it is worth. If its opponents would get up a *system* of their own there would be less chance of its success. Its main advocates are scientific rather than practical men, who make use of the less important parts of the system.

Taking up these points in reverse order, we remark that the less important part of any system of weights and measures is that which this designation indicates, with measures restricted to those of capacity. Measures of length form the most important part of any system. Measures of quantity and weights of different kinds often exist, and are in common use together without difficulty, though in scientific work involving accurate calculations trouble may result. Now, those who advocate a legal compulsory introduction of the metrical system are mainly interested in this end of it, and have little idea of it from the other and more important one. Standards of length lie at the foundation of all our important and accurate manufacturing and engineering work, and an examination of the necessities of this work, in both its theoretical and practical parts, shows that a change to the metrical system would be not only very expensive, but detrimental. It is difficult to estimate the cost of a change from the inch, with its multitudinous ramifications throughout the mechanical world, to metrical units; it would be enormous, and what advantages has metrical measure that the inch may not have, and much more? As to the size of it, the meter has nothing better to offer; and as to its subdivisions that into sixteen parts is far better that that into ten, except for certain purposes of calculation, and here the right thing to do is not to change to ten, but to so improve calculation by sixteenths as to make it also better than reckoning by tenths. This leads to the next point, or that of a system of calculation by sixteenths which shall be superior in all points to that by tenths.

The doubts that one may have as to the possibility of this are illusory, and mainly founded on the mistaken idea that the advantage of the so-called decimal system has anything to do with the number ten. 'Decimal' is a misnomer. 'Digital' would be quite as good, but neither touches the system itself, which consists in the values of the consecutive places, units place, tens place, etc., being in geometrical progression. The system would exist and have its characteristic advantages with any number as the ratio of this progression.

Now, sixteen is in many ways a better number than ten, and the change to a system having sixteen as its ratio or root would be such a change as a Chinaman has to make in adopting a European language with its methods of writing and printing and reckoning. A Chinaman might not understand if he were told that his language was inferior, say, to German, any more than a devotee of the meter can see that his idol is at most a poor stick lacking in the proportions needed for common measurements.

The next or first point follows from this,

which becomes clearer as the matter is further examined, and the peculiar collateral advantages of sixteen are appreciated. To do this fully will require another paper, but some of them may be mentioned in the hope of eliciting comment and discussion.

The Drainage Problems of Irrigation: C. G. Elliott, Washington, D. C.

A new problem confronts the owners of irrigated lands. The leakage from canals, and over-irrigation by users of water, have destroyed the productiveness of land by producing saturation of soils in certain localities, and resulting alkali conditions. Well-directed drainage operations will reclaim such lands and protect those which are threatened with the evil.

Second Law of Thermodynamics: J. Burkitt Webb, Hoboken, N. J.

Various attacks have been made on this second law, and in a recent one by Jacob T. Wainwright, of Chicago, of which I shall not attempt a full criticism, there are some peculiarities, two of which may be worthy of remark.

In the first place the writer seems ignorant of, or avoids, Rankine's work in this direction, which, to my mind, contains the best statement and proof of the law, in no way touched by his remarks.

The proof is like a nutritious nut—crack the shell, or, failing that, gnaw through it, and you have a perfect kernel, the living germ of the second law, from which so much valuable fruit has sprung.

The simplicity of the proof makes the nut hard cracking for some. He holds that evidently heat is of such a simple, homogeneous nature that all its differential elements must have the same effect, and, further, that all the infinitesimal elements of temperature must have equal effects, which last is analogous to the statement that when the camel's back breaks each element of weight has the same effect—the first straw being equal with the last in the actual catastrophe. From this the division of each element of heat by its absolute temperature and the second law follow easily.

Secondly, the author's claim that Clausius's proof is faulty (as I pointed out years ago) is correct. Clausius proves the form of his function on the principle that in a reversible cycle all natural working substances must be equally efficient, and then attempts to define the function exactly by discussing the properties of a perfect gas—a theoretical working fluid which does not exist in nature. The proof, therefore, fails in default of a further investigation showing that the absence of the natural properties which a theoretically perfect gas lacks does not vitiate the result.

Theory, Construction and Use of a Pressure-tube Anemometer: A. F. Zahm, Catholic University, Washington, D. C.

The present paper describes the design and use of a pressure-tube anemometer whose observed readings conform to those required by theory. The instrument consists of a double-pressure nozzle connected with a differential pressure-gauge. One nozzle transmits the direct impact of the air, while a side nozzle gives the static pressure of the current at the same point. Their difference is theoretically proportional to the velocity-head, and serves to determine the velocity of the air when its density is known. To prove the agreement of the theoretical and actual pressures sustained by the nozzles, the following facts are experimentally established: (1) The pressure on the direct impact nozzle is proportional to the total head; (2) the pressure on the side nozzle equals the true static pressure of the point; (3) the differential pressure is proportional to the true velocity head, since the velocity

calculated therefrom equals the known velocity of the air; (4) the differential pressure varies exactly as the square of the velocity, as required by theory. The air velocities employed ranged from five to thirty miles an hour, and the pressure gauge was graduated to millionths of an atmosphere. The experiments were conducted in a tunnel through which air was drawn with uniform velocity and direction, its velocity being measured simultaneously by the pressure-tube anemometer and by a balloon anemometer. In the latter device a toy balloon drifting through the tunnel cuts two pencils of light thrown squarely across its path at an interval of ten feet, the time between the cutting of the sheets of light being determined photographically. The average wind-speed determined by means of the pressure-tube anemometer agrees with the average determined by the standard, or balloon anemometer, accurately to less than one per cent. Examples are also given of the use of the pressure-gauge for measuring static pressures from one millionth of an atmosphere upwards.

Hydrographic Work of the U. S. Geological Survey: H. A. PRESSEY, Washington, D. C.

The work of the Survey in measuring the flow of all the important streams in the country is described, and the great value of the results to industrial projects pointed out.

Friction in Ball-bearings: M. J. GOLDEN, Purdue University, Lafayette, Ind.

The paper describes an apparatus used to determine the friction of ball-bearings of different sizes at different speeds. It was shown that at high speeds ball-bearings fail entirely. Ball-bearings for ordinary pressures and speeds give a loss by friction less than that of an ordinary bearing poorly lubricated, but not much less than a finely polished and thoroughly lubricated bearing.

Errors in Analyses of Furnace Gases Shown by Computation: WILLIAM KENT, Passaic, N. J.

It is shown by arithmetical computation based on the analyses of a certain coal that the analysis of the gas from the chimney, as reported by the chemist, must be in error. With such an analysis it is impossible to compute a heat balance in a boiler test with any approach to accuracy.

Heat Exchanges Within the Steam-engine: R. H. THURSTON, Cornell University, Ithaca, N. Y. (Not read.)

The method of heat exchange in the steam-engine cylinder, which results in serious wastes of heat and proportional reduction of the efficiency of the machine, has been considered an obscure phenomenon. The experiments made by Professor Dwelshauvers-Dery and by M. Duchesne indicate that the cylinder wall takes the temperature of the steam as long as it is covered with moisture; but when the wall is dry it may hold a temperature considerably in excess of that of the steam in contact with it. During expansion and compression of steam in the cylinder there is a constant interchange of heat, which accounts for the varying efficiency of the steam as a motor. Experiments conducted at Sibley College of Cornell University sustain these deductions. The experiment is described and results shown graphically.

ELWOOD MEAD,
Secretary.

SECTION E, GEOLOGY AND GEOGRAPHY.

SOME forty-five papers were offered to Section E for reading at the Washington meeting. On account, however, of the conflict with the meeting of the Geological Society of America, all the papers of the Section E program were accepted by the

Geological Society for reading before that body as a part of its program, with the exception of five which were read before Section E Monday afternoon (there being no vice-presidential address this year), and the papers dealing with the Lesser Antilles and the recent eruptions there, which were read before the same body Friday morning, the Geological Society adjourning at that time for the purpose of attending the meeting of Section E.

The Shifting of Faunas as a Problem of Stratigraphic Geology: HENRY S. WILLIAMS, Yale University.

A comparison of sections through the Upper and Middle Devonian rocks of the New York-Pennsylvania province discloses marked differences in the faunas which occur at corresponding levels. The explanation of the facts is found in the shifting of faunas during the time represented. The paper discussed at length the nature, extent and mode of recognition of faunal shifting in studying stratigraphy, and modifications were suggested in the customary practice of correlating formations by their fossils.

Some Relations of Tertiary Formations of the Northern Great Plains: N. H. DARTON, U. S. Geological Survey.

For several field seasons, the author has given a portion of his attention to the formations from Oligocene to Pliocene in age of Nebraska, South Dakota and eastern Wyoming and Colorado. Structural and stratigraphic relations have been determined, and the origin and geologic history of the formations have been considered. In studying the Black Hills, Big Horn Mountains and Laramie range, it has been found that there are extensive overlaps of the White River Oligocene beds to high altitudes where there are old shore lines which define some of the physiographic conditions. The materials of the formations have been deposited principally by streams, but at some points fine-grained materials have been laid down in widespread overflows or in local lakes and bayous.

The Economic Geology of Michigan: ALFRED C. LANE, Lansing, Mich.

The author defines economic geology as the science of raw materials. The effect of the presence of these materials upon industry and the effect of geological conditions upon their development were illustrated by reference to several Michigan products. Such factors were considered as the position of the state in the center of the Great Lake distributing system, the tilting of the Great Lake basin and its effects, the mutual relations of coal and iron and the development of the iron-ore business, the peculiarities of lake copper as compared with that of the far west. Salt, limestone and lumber and their mutual relations, the coal basin and the causes of its retarded development, were considered.

Some Results of the Lake Minnesota Geological Survey: N. H. WINCHELL, Minneapolis, Minn.

This paper mentioned: (1) Some of the scientific conclusions, and (2) some of the known economic results of the Survey presented in the final report. (1) Scientific: (*a*) The identification of the parts of the Upper Cambrian, (*b*) the definition of the Lower Silurian, (*c*) the determination of the extent of the Cretaceous toward the east, (*d*) the definite determination of the duality of the ice epochs, (*e*) the determination of the duality and alternation of the ice lobes and the resultant glacial lakes, (*f*) the discovery of the duality and later of the triple character of the iron horizons of the Lake Superior region, (*g*) the separation of the Archæan into two non-conformable parts, (*h*) the discovery

that the Animikie overlies both parts of the Archæan non-conformably, (*i*) the recognition of the igneous origin of the green-sand of the Animikie, (*j*) the determination of the igneous origin of the jaspilytes of the Mesabi and Vermilion ages, (*k*) the addition of numerous minerals to the geographic area of the state, (*l*) the determination of the metamorphic origin of gabbro from Archæan greenstone, and (*m*) of granite from Archæan sediments. (2) Economic and educational: (*a*) Determination of the cause of foul waters in the prairie region, (*b*) the demonstration of the excellence of the Hinckley sandstone and its consequent wide adoption, (*c*) the discovery and announcement of the Mesabi iron ores, (*d*) the distinction of the gabbro (igneous) ores from the Mesabi iron range, (*e*) the delineation of the Mesabi belt as distinct from the Vermilion, which has facilitated search and exploitation, and (*f*) the demonstration of the utility of intrusting geological surveys to the state universities.

Current Work in Paleontology in New York State: JOHN M. CLARKE, Albany, N. Y.

(*a*) The Guelph reefs and their faunas. Recent investigations have shown an excellent development of the Guelph fauna at at least two stages in the Upper Siluric dolomites of New York, and an analysis of the character of the species and the nature of the enclosing rock indicates that the fauna flourished on and about coral reefs in the shrinking sea. (*b*) The faunistic provinces of Portage time. In addition to the provinces already established during this stage in New York, viz., the eastern or Oneonta, the central or Ithaca, the third or Naples (= true Portage). The last proves to be divisible into sub-provinces, depending upon the degree to which this fauna, advancing from the west, penetrated eastward. The migration path of the fauna is from the northwest. (*c*) The causes of depauperation in pyrite faunas. Investigation of the organic contents of the sheet of pyrite lying in the horizon of Tully limestone for a distance of one hundred miles in western New York gives some clue to the causes which have effected like results in similar occurrences of other age. (*d*) The determination of the uppermost Cambric in eastern New York. This pertains to the discovery of the horizon of *Dictyonema* and *Clonograptus* in Rensselaer County.

On an Important but not Well-known Locality Furnishing Cretaceous Fishes: O. P. HAY, American Museum of Natural History.

The paper called the attention of geologists and collectors to a locality in the region about Yankton, South Dakota, from which Dr. F. V. Hayden obtained several species of fossil fish for Professor E. D. Cope. Most of the genera are related to or identical with genera from Mount Lebanon, Syria.

Quantitative Chemical-mineralogical Classification of Igneous Rocks: WHITMAN CROSS, J. P. IDDINGS, L. V. PIRSSON and H. S. WASHINGTON.

The presentation of the subject embraced a statement of the needs and the occasion for such a classification of igneous rocks; the principles on which it is based; the method of procedure employed to produce quantitative subdivisions of rock magmas; the method of expressing the actual mineral development (composition) and texture of the rocks; the nomenclature proposed; the proposition to establish a classification and nomenclature for use in field work, and for general geological purposes. The presentation closed with a correlation of the quantitative classification with the one in use at present.

Dikes in the Oklahoma Panhandle: C. A. Waldo.

In this paper the author referred to the discovery of mineral dikes in the extreme northwest townships of Oklahoma Territory. This section has not been carefully mapped by the U. S. Geological Survey, and it is a region about which little has been written. The discovery of the dikes resulted from an attempt to explain the existence of extensive mineral deposits in that locality, and was accomplished after the failure in this particular of several experts and hundreds of professional mineral prospectors.

The Geographic Development of Western Pennsylvania and Southern New York: Marius R. Campbell, U. S. Geological Survey.

His study of the upland features of western Pennsylvania and southern New York has satisfied the author that this plateau is not as old as the deeply dissected upland of the bituminous coal field of West Virginia and Kentucky. The latter is generally regarded as of Cretaceous age; therefore, the former must date back only to some part of the Tertiary. In reviewing the work of Professor Davis in the eastern part of the state, the author finds evidence of a peneplain intermediate in position and age between the Schooley (Cretaceous) and the Somerville (Tertiary) peneplain. This newly-recognized feature is called the Harrisburg peneplain, from its extensive development in the belt of shale hills back of that city. It appears that from whatever point this peneplain is traced it rises toward the New York line, and the author has provisionally correlated it with the general upland tops already mentioned in the plateau region of northern Pennsylvania and southern New York. If this correlation is correct, the peneplain has been deformed into an ellipsoidal, dome-shaped structure whose major axis extends in a northeast-southwest direction, and whose maximum development is attained in Potter and McKean Counties, Pennsylvania.

The Blue Ridge of North Carolina: William Morris Davis, Harvard University.

The Blue Ridge in northern North Carolina and southern Virginia is not properly a ridge with strong slopes descending on either side of its crest line, but it is an escarpment separating an uneven and often mountainous upland on the northwest from a rolling and occasionally mountainous lower land on the southeast. The escarpment is not determined by variation of structure in the disordered schists in which it is carved, but by the unequal length of the rivers which drain the upland back of it in the northwest and the lower land in front of it on the southeast. The high level head-waters of the northwestern rivers, which discharge *via* the Mississippi into the Gulf of Mexico, are constantly losing length by the retreat of the escarpment through the retrogressive erosion of the low level head-waters of the shorter Atlantic stream. There is no local indication that the sea has had any share in producing the escarpment.

The Fresh-water Tertiaries at Green River, Wyoming: William Morris Davis, Harvard University.

This paper gave an account of some detailed observations on the stratigraphy of the Tertiary strata at Green River, showing the occurrence of variable deposits, including frequent cardboard shales, alternating with cross-bedded, ripple-marked sandstones and with occasional shale-pebble beds. An inquiry into the nature of strata deposited in large lakes and on the stream-washed surface of interior basins

leads to the conclusion that the Green River Tertiaries are not simply the continuous deposits of a single large lake, but that they are the deposits of many successive shallow and fluctuating lakes of moderate area combined with the deposits of numerous aggrading streams.

A Highly Viscous Eruption of Rhyolite: G. K. GILBERT, U. S. Geological Survey.

A butte of rhyolite in western Utah illustrates the viscosity of acid lavas, and thus helps to sustain the theory of Dutton for the dynamics of eruption.

Physiographic Belts in Western New York: G. K. GILBERT, U. S. Geological Survey.

The physiographic belts recognized by Lincoln can now be studied in part with the aid of contour maps. South of the drumlin belt is a zone of great glacial erosion in which the aspect of the land was revolutionized by ice sculpture. It is limited southward by a great moraine, beyond which the upland drainage is pre-glacial, and in which the glacial modification of hill forms diminishes rapidly to the glacial boundary.

Some Shore Features of Lake Huron: M. S. W. JEFFERSON, Ypsilanti, Mich.

This paper reviewed the shore features, such as dunes, beaches old and new, town sites and river erosions, at Kincardine, Ontario, with regard to Kincardine's position nearly 100 miles north of Gilbert's isobase line. Comparison was made with points to the south of the same line, as Muskegon. Kincardine is regarded as possessing a lake and bar separating it from Lake Huron, modified in a manner appropriate to an uplift of the smaller lake bed to a height of about 70 feet above the great lake, with resulting elevated beaches, deeply cut stream valleys, limited dune sand and increased river sediments.

The Topographic Work of the Geological Survey in Northern Canada: ROBERT BELL, M.D., Acting Director Geological Survey Department, Ottawa.

Previous to the confederation of the Canadian provinces in 1867, and the subsequent acquisition by the Dominion of the other British possessions in North America, including British Columbia, the territories of the Hudson Bay Company, the Labrador peninsula and all the islands lying north of the mainland of North America, the operations of the Canadian Geological Survey were confined to the southern parts of the areas which now constitute the provinces of Ontario and Quebec. Since confederation, however, the attention of the department has been directed to surveying these vast, newly acquired territories and the regions which have been added to Ontario and Quebec. These tracts were entirely unsurveyed and only partially explored, the main geographical features alone being roughly indicated on the maps. The subdividing of the fertile lands of Manitoba and the Northwest Territories was performed by a different department, and its work added little to the knowledge of the topography of the country. The fieldmen of the Geological Survey have been the pioneer surveyors of the natural features of the vast regions which constitute half the continent. In order to map out the rock formations, the geologists found it necessary to make topographical and geological surveys simultaneously. From their long experience in these operations, they have been able to do this work rapidly and well, and the object of this paper was to show the astonishing amount of accurate geographical work which has been accomplished by a small number of devoted men with very limited means at their disposal.

The Saddle-back Topography of the Boone Chert Region, Arkansas: A. H. Purdue, University of Arkansas.

The rocks exposed in northern Arkansas are those from the Silurian to the Upper Carboniferous inclusive. The position of the rocks is essentially horizontal. In the western part of the region north of the Boston Mountains, the prevailing surface rock is the Boone chert; but in central northern Arkansas erosion has continued far below the Boone chert, exposing the Silurian rocks, except where there are monadnocks. These monadnocks are of necessity greatly dissected by small mountain streams which are cutting their way headward into them. The spurs between these streams are frequently surmounted by one or more knobs, which produce the saddle-back topography so common in the region. These knobs are always capped by fragmentary Boone chert, which in some cases is partly water-worn. That the water-worn material is not due to submarine action is proved by the fact that it is found only locally. It follows that it must be of stream origin.

The knobs owe their existence to the formation of alluvial cones by former streams at the time when the stream beds were on the level of the present knobs. The cones of the fragmentary chert obstructed the streams, causing them to shift laterally, and at the same time protected the subjacent rocks from erosion. If conditions were favorable, two or more cones were formed by the same stream at different stages in its history, a knob resulting from each cone, and a series of knobs indicating the former course of the stream. The paucity of the water-worn material in these old cones is explained by the streams that formed them having been short and of a torrential nature. The present drainage of the region is like that at the time the Boone chert was the prevailing surface rock only as regards the master streams; and the change is due in a large measure to the shifting of the streams brought about by their own obstructions.

Scientific Relief Maps: George Carroll Curtis, Boston, Mass.

For years past the scientific bureaus of the United States have deemed it advisable to construct relief maps. The Paris Exposition of 1900 afforded a just international comparison; and it was found that America was exhibiting work which fell far behind that of some of the European countries, because of the lack of scientific methods.

A perfect topographic relief map is a perfect miniature or model of nature; and, unless natural laws and principles are employed in its construction, no progress beyond the old relief map will be attained. Truthful topographic modeling is an exact art requiring accurate, rational and systematic methods throughout the gathering of data upon the field, and the application and reproduction of the facts of nature in other dimensions. Modern scientific inventions, including contour maps and dry-plate photography, are aiding in bringing this work toward perfection and into recognition.

Lunar Calderas: E. Hayes, Wellesley College.

Every topographic feature of the moon is invested with mystery and difficulty. Some forms, however, invite study and discussion, because of their likeness te certain earth forms. Among these are the so-called 'ring-plains.' They consist of a circular wall, composed often of lofty mountains enclosing an approximately horizontal floor which is generally broken by a central cone. The prevailing theories of their formation are untenable, for both dynamic and topographic reasons. On

comparing such a ring-plain as Theophilus, for example, with the Hawaiian calderas studied by Dutton, we are led to assign to these lunar rings an origin similar to that of terrestrial calderas.

Evidences of Post-Newark Normal Faulting in the Crystalline Rocks of Southwestern New England: WILLIAM H. HOBBS, University of Wisconsin.

The study, in 1899, of the Newark area of the Pomperaug valley in Connecticut disclosed conditions of deformation which have made it possible to work out, in part at least, the structure of the crystalline rocks surrounding the Newark basin. The key to the structure has been sought and, it is believed, found in these areas where the areal relations seem most complex, or where, in other words, a large number of formations are found in small masses within a very limited area. Such areas of complex areal relations have generally been regarded as ill-adapted for structural studies. They have also been generally neglected for the reason that the determination of their structure would be time-consuming, and, when once determined, could hardly be represented upon geological maps of the ordinary scale. The studies here under consideration have shown that, complex though they may be, the very complexity of these areas will generally allow of but one theory of their structure, provided the data collected are sufficiently complete. On the other hand, areas of the crystalline rocks in which formations are represented at the surface by large masses are apt to allow of a number of theories of interpretation, any one of which may furnish an adequate explanation of the facts observed. It has been by the detailed study of a number of widely separated areas of excessively complex areal relations that the conclusions here stated have been reached.

It was shown that the area of southwestern New England is one of complexly jointed and faulted, as well as of complexly folded, rocks. The system of faults affecting the area is found to be oriented like the system of joints. The throws along fault planes, while generally small, are, owing to the great number of faults involved, by their cumulative effect of great importance. Methods have been developed by which the *fault system* of an area may, under favorable circumstances, be determined from observation in the field.

A Record of Post-Newark Depression and Subsequent Elevation within the Area of Southwestern New England: WILLIAM H. HOBBS, University of Wisconsin.

Within a belt some twelve miles in length, lying between Sheffield, Mass., and Falls Village, Conn., there are revealed some peculiar conditions of the impregnation of dolomite by silica. The trunk lines for the introduction of the silica are shown to be a system of joint- and fault-planes clearly connected with the Post-Newark deformation of the area. Evidence is not lacking that surface conditions widened the joint fissures previous to the infiltration and cementation by silica. A measure of time is thus secured within which the cycle of subsidence, cementation and elevation, must have been included.

Criteria Requisite for the Reference of Relics to a Glacial Age: T. C. CHAMBERLIN, Chicago University.

What constitutes good grounds for referring relics (human, in particular) to a glacial age, and the chief sources of error in making such reference were discussed under the following sub-topics: Evidence to be sought in the glacial formations themselves; evidence from the bowlder clays; evidence from assorted drift included in till and moraines; evidence from

kames and eskers; confirmatory evidence in these cases; combined evidences; the cumulative value of repetition; the interpretation of imbedded and striated relics; evidences from the interglacial deposits; evidences from assorted drift lying upon or outside of the true glacial series, river deposits especially; scour-and-fill; unequal effect on aggrading and degrading rivers; breadth of action in the great streams of the glacial area; adjustment plains as sources of deception; amount of the errors; flood-plain deposits; bluff-border accumulations; derivative formations; decomposed secondaries; the meaning of a principal river as a cause of alternate erosion and deposition in the mouth of its tributary valleys, and association with certain extinct animals not a criterion.

Glacial Cirques and Rock-terraces on Mount Toby, Massachusetts: B. K. Emerson, Amherst College.

Mount Toby is composed of coarse Triassic conglomerates, and, being placed in the lee of the great ridge of the Deerfield trap-sheet, has been especially protected from the erosive action of the inland ice of the glacial period. The mountain is now cut into deep amphitheaters with strong, often vertical walls which head against an extremely narrow ridge, and are separated by ridges which are crossed by many vertical rock-terraces from ten to a hundred feet high, most of which seem to be formed by the plucking action of the ice. They do not cross the cirques, which are deeply filled with foreign glacial material. They seem to have been formed by small glaciers, and then overridden and filled by the main ice-sheet.

Protection of Terraces in the Upper Connecticut River: C. H. Hitchcock, Dartmouth College.

Recent papers by Professor W. M. Davis propose the theory that many alluvial terraces are kept in place by underlying ledges. First, the high flood-plain was deposited by the river, enormously developed through melting of the ice-sheet. Next, as the waters diminished in volume, a large excavation was made in the high plain, and the steep slopes resulting are the escarpments of terraces. These terraces are variable in bulk and number, and it has been a difficult matter to explain these variations. As the river swings back and forth over the low ground, it meets ledges which it is unable to remove; neither can it remove the earth superimposed upon them. In other words, the ledges protect the terraces behind them from destruction. It is common to see a ledge at the extreme pointed end of a terrace, and the terrace broadens as you follow it back. The outer edge below the ledge will ordinarily be curved. The localities described by Professor Davis are at Westfield, Mass., and Bellows Falls, Vt. I have extended the observations above that point, especially between White River Junction and Wells River.

Glacial Features of Lower Michigan: Frank Leverett, Ann Arbor, Mich.

The paper was illustrated by maps and diagrams setting forth the relation of the Michigan, Saginaw and Huron-Erie ice-lobes in lower Michigan during the Wisconsin stage of glaciation, and represents three years of field work for the United States Geological Survey. Especial attention was given to eskers, and their bearing upon the question of superglacial or subglacial origin is discussed. An extensive drumlin area was briefly described in its relation to ice movements and moraines. The paper closed with reciting the evidences of earlier ice invasions than the Wisconsin which have been found within the limits of the Wisconsin drift.

Studies in the Glaciation of the Berkshire Hills, Massachusetts: FRANK B. TAYLOR, Fort Wayne, Ind.

The Berkshire Hills lie within the area covered by the retreating Hudson Valley lobe of the Labrador ice-sheet. The retreat of the ice-front across Berkshire County was from southeast to northwest and the trend of the front was northeast and southwest, the apex of the lobe resting on the central axis of the Hudson Valley. In the lower, less mountainous region near the Hudson River, the moraines and border drainage features, though faint, are continuous, so that the positions of the ice-front at its several halts are traceable continuously. In Berkshire County continuous tracing is not possible, the borders there being marked by fragmentary terminal and lateral moraines, mostly very slender, and by remains of border drainage. The extremely serrate character of the ice margin at each halt, coupled with the frequency of the halts, makes interpretation difficult. The average interval between successive recessional moraines is about three and one half miles. The paper was devoted mainly to a discussion of the method of interpretation, showing, first, that, by the circumstances of the recession across this county, the moraine marking each halt of the ice-front may be safely regarded as an individual, separate and distinct from the moraines of earlier and later halts; and, second, that interpretation on this assumption unifies and explains the morainic phenomena of Berkshire County satisfactorily.

The Geological Age of the West Indian Volcanic Foundation: J. W. SPENCER, Toronto.

From personal explorations the author has found that the whole Caribbean plateau is underlain by an igneous basement of pre-Tertiary age. This foundation occurs not merely beneath the older Tertiary limestone, but also on those islands where such have not accumulated, or have been removed by denudation, and are now surmounted by volcanic ridges. The igneous formations have been analyzed, and their relationship to the later fossiliferous deposits show that the volcanic activity was renewed about the close of the Pliocene period, and has continued intermittently since that time. And it also seems probable that there was a long quiescence during the greater part of the Tertiary period.

The Geologic and Physiographic History of the Lesser Antilles: ROBERT T. HILL, U. S. Geological Survey.

The author stated that the Windward chain of islands from the Anegada Passage to the South American coast consisted of three distinct types of islands: (1) Those of the Virgin chain, which were Antillean in their relationships; (2) those of the Caribbee chain, which were constructional volcanic forms; and (3) islands of the Trinidad type, which were detached portions of the South American continent. Besides these types there is the semblance of an outer circle of islands, including Antigua, Grande Terre (Guadeloupe) and Maria Galante, consisting of marine sedimentaries veneered upon old volcanic piles. Barbados is in a class by itself, with probably South American relations. Vulcanism has prevailed in the Caribbean islands since Cretaceous time, and the volcanic ejecta have consisted essentially of horneblende-andesites throughout. Physiographically the islands are of several distinct types. The Caribbee Islands proper are strictly constructional forms modified somewhat by rainfall erosion, and truncated around the edges by marine erosion. The changes of level have been more or less epeirogenic, but never, at least since Jurassic times, has there been any connec-

tion between the Windward Islands and the mainlands. There is absolutely no topographic or geologic proof that the volcanic Caribbees are of other than progressive constructional origin, or that any continent or semblance of a continent ever prevailed on their present site.

Mont Pelée—the Eruptions of August 24 and 30, 1902: Angelo Heilprin, Philadelphia, Pa.

The paper described the author's experiences during the great eruptions of these dates, being actually high upon the eastern slope of the volcano during the outburst of August 30, when Morne Rouge was destroyed. Morne Rouge was destroyed by a volcanic blast from the crater similar to that which devastated St. Pierre early in May. Lantern slides from the author's negatives showed the inner cone overtopping the rim of the ancient great crater.

The Principal Causes of Death during the Eruptions of Mont Pelée and La Soufrière: Israel C. Russell, University of Michigan.

A review was presented of the evidences bearing on the question mentioned in the title, and arguments brought forward to show that the chief agent of death was highly heated, dust-laden steam.

Secondary Volcanic Phenomena of the West Indian Eruptions of 1902: George Carroll Curtis, Boston, Mass.

Fresh evidences of geologic work, which could not be credited to the main phenomena of eruption alone, were found by those early upon the field after the West Indian eruptions in 1902. Over the area lay a large amount of volcanic ejecta upon which erosion forces were rapidly working. An excellent opportunity was thus afforded for the study of stream development upon an initial cover. Portions of the coastal plain had subsided; other deposits had undergone elevation; tidal waves had swept the marginal slopes; and marine erosion was rapidly altering new deposits. Flows of mud-like detritus had filled valleys, extended their deltas seaward, entombing villages and inhabitants. From the valley floors minor eruptions were taking place, giving rise to early reports that lateral craters connected with the main source of volcanic energy had played important parts in the great eruptions. Detailed study of these eruptions on the actual ground indicates that they were not from a primary volcanic source, but that they formed a series of secondary manifestations with origin, process of outburst and topography developed peculiar to themselves.

Some Erosion Phenomena on Mont Pelée and Soufrière: Edmund Otis Hovey, American Museum of Natural History.

The stripping of the volcanoes Pelée and Soufrière of all vegetation by the eruptions, and the deposit of fresh fragmental material over the whole, gave excellent and unusual opportunity for observation of the development of new erosion forms (particularly dendritic drainage) on old surfaces.

The Inner Cone of the Mont Pelée Crater and its Relation to the Destruction of Morne Rouge: Edmund Otis Hovey, American Museum of Natural History.

The growth of the inner cone of eruption above the western opening beside Étang Sec caused the partial closing of the great gash in the side of Mont Pelée, and finally lifted the main vent above the rim of the great crater, to a point where there ceased to be any hindrance to the radial expansion of the explosions.

Origin of the Sandhill Topography of the Carolinas: Collier Cobb, University of North Carolina.

Many of the sandhills show the structural features of æolian cross-bedding seen on Hatteras. Unlike most dune sands,

those of the Carolina coast contain many fragments of potash feldspar, being essentially the same in composition as the beach sands, which may account for the presence of the potash in the coastal plain soils, while explaining the origin of some of the topographic features.

Recent Changes in the North Carolina Coast, with Special Reference to Hatteras Island: COLLIER COBB, University of North Carolina.

Hatteras Island is being added to on the sound side and taken from on the ocean side north of the cape, and a new inlet is being made between the cape and Kinnakeet. South of Cape Hatteras the island is growing on both sides, but is extending in a southeasterly direction. The rate of change has been noted by the planting of cedar posts, and noting the changes of shore line with relation to posts, trees and various natural objects through the years 1892–1902.

The Hanging Valleys of Georgetown, Col.: W. O. CROSBY, Massachusetts Institute of Technology.

The paper describes chiefly the break of several hundred feet between the floor of the valley of Clear Creek and that of Leavenworth Creek, one of its principal tributaries, and explains it as due, not to fluvial or glacial erosion, but to faulting, of which abundant independent evidence is afforded by mining developments. Other and similar features in the vicinity were correlated with this, and it was shown that the part of the main valley occupied by Georgetown is a depressed fault-block or graben, and that the valley is, therefore, due in part to displacement and not wholly to erosion, suggesting comparison with Yosemite Valley. The idea was also advanced that the elevation of this oldest of the Colorado ranges has been recently, and may be still, in progress, and that while in the past the movement has been chiefly massive, developing the great fault-scarp overlooking the plains, it has in later times affected the axis more than the axis of the orographic block, leading to a marked tilting of the Cretaceous peneplain; and in part, at least, it is very locally differential, and in the Georgetown instance in a degree to accelerate the topography.

Further Notes on Lake Arickaree: J. E. TODD, Vermilion, S. D.

Lake Arickaree was a glacial lake formed in the valley of Moreau and Grand Rivers, South Dakota, with its axis corresponding with the Missouri River in that region. The region was first visited by the author in 1890, and a description of its peculiar southern margin preserved as a bowldery ridge above the north side of Fox Ridge, reported in 'Bulletin 144' United States Geological Survey. He visited the region again this past summer, discovered another outlet, and traced the margin more definitely.

The Problem of the Loess in the Missouri Valley Compared with that in Europe and Asia: G. FREDERICK WRIGHT, Oberlin College.

The physical resemblances between the loess deposited in the Missouri Valley and that in southern Russia and in Turkestan and northern China are perfect; but in general distribution there is great diversity. In China the deposits occur in vast wind-blown masses near the summits of the mountain-border on the east coast of Mongolia, up to five thousand feet above the sea. Elsewhere, however, only in the lower areas are they distributed over level areas, evidently by water action; while at the head of the plain extending west from Peking, near the Nankau Pass, there are evident deltas six hundred feet above the sea, consisting of loess mingled with large transported blocks of rock. Along the

northern base of the Ala Tan Mountains in Turkestan, and along the western base of the Thian Shan Mountains, the delta-like characteristics of the distribution are evident, maintaining a pretty general level of twenty-five hundred feet above the sea. Over the southern plains of Russia the deposit maintains a pretty general level of six hundred feet, having a scope of from fifty to a hundred feet over everything, though the rivers have cut channels three hundred feet deep in the more southern portions.

In the Missouri Valley there is also a definite relation to the streams. On both sides of the Missouri the deposit is developed from Yankton to Kansas City in almost equal degree, having a depth of a hundred feet or more. Both in the Missouri Valley and in the lower levels in China there are also frequent indications of water action in more or less obscure lines of bedding, while in both areas fossils are scarce, and are mostly of land species which love moist places. In China the source of material is certainly not from a glaciated area, while in the Missouri Valley it is probably both from the adjacent glaciated area and from the arid plains to the west. In both areas the distribution by water is best accounted for on the theory of an extensive subsidence of land over the entire northern hemisphere. In the Missouri Valley the following order of earth movements seems best to fit the facts:

1. Pre-Glacial elevation of two thousand or three thousand feet. This continued until the close of the Kansas stage.

2. Depression increasing toward the north until the level was considerably below present level. This closed the Iowan stage, and was accomplished by the main loess deposits, while the gradient of the river was reduced to a few inches per mile and the water action increased from ten to twenty feet during the late summer melting of the ice, covering all the adjoining land for a few weeks, and then leaving it bare for the rest of the year. Thus the peculiar fossils may be accounted for.

3. An elevation increasing to the north with an east and west axis near the latitude of Omaha, culminating in the Wisconsin stage. The once waste grounds from the Wisconsin moraines down the Big Sioux River are a mile and a half wide and only ten feet above the present flood plain. These continue for a little distance down the Missouri after reaching Omaha. Below Omaha there has been filling, instead of erosion, since the Wisconsin stage. This would give to the loess deposits of undoubted Iowan age.

A New Meteorite ('Bath Furnace') from Kentucky: A. M. Miller, Lexington, Ky.

The meteorite exhibited was the one which occasioned the brilliant display seen at 6.45 P.M. of November 15 by many persons in the states of Ohio, Kentucky, Tennessee, Louisiana, Mississippi, Alabama and Georgia. Its detonations, associated with the checking of its orbital velocity by the resistance of the air, startled the inhabitants of Bath County, Kentucky. It actually struck the earth in the road in front of the house of Mr. Bluford Staten. The latter, an eye-witness of the event, picked the stone up on the following morning. It passed next into the hands of Mr. W. H. Daugherty, of Owingsville, Ky., from whom it has been purchased by Professor Henry A. Ward for the Ward-Coonley collection, New York City. The meteorite is an aerolite containing, among other substances, disseminated nickeliferous iron, and it exhibits the usual black crust with pittings. Before chips were removed for analysis the specimen weighed nearly thirteen pounds. Specific gravity, 3.48.

Science at the World's Fair, St. Louis, 1904: J. A. HOLMES, St. Louis, Mo.

The exhibits at the approaching Universal Exposition to be held in St. Louis, from April 30 to December 1, 1904, will endeavor to show the applications of science in all the great industries of the country; and in some of these departments, notably that of mines and metallurgy, it is proposed to show the equipment and methods of geological surveys and similar institutions for geologic, geographic and metallurgic research; in fisheries will be shown methods and equipment for biologic research; in liberal arts, laboratory research equipment in many branches of science; in education, equipment and methods of instruction and research at the institutions of learning; in the department of electricity will be shown modern equipment and methods of electrical research. In addition to the above, arrangements are being made for holding, under the auspices of the exposition, a number of scientific congresses for the discussion of methods and equipment, and general plans for research, in all departments of knowledge.

EDMUND OTIS HOVEY,
Secretary.

OPENING EXERCISES OF THE WASHINGTON POST-GRADUATE MEDICAL SCHOOL.

THE opening exercises of the Washington Post-Graduate Medical School were held in the presence of a distinguished audience on Monday evening, January 12, 1903, at 8 o'clock in the lecture hall of the Columbian University.

Addresses were delivered by Professor Wm. H. Welch, M.D., of Johns Hopkins University, and by the president of Columbian University on behalf of the educational institutions. The rector of Georgetown University was unable to be present, but sent words of welcome and encouragement to the new school.

Professor Welch emphasized especially the many advantages of the National capital as an educational center, and spoke in the most appreciative terms of the work performed in the government laboratories, by men who are also connected with the teaching staff of the graduate school. The speaker expressed great gratification that the department of preventive medicine had been given deserved prominence, and in this respect characterized the attempt as unique, in this country at least, and one which could not fail to be appreciated by all interested in scientific medicine. He referred to the advantages which must accrue to the students by the utilization of the hygienic laboratory of the public health service, the laboratories of the Army and Navy Medical School, the biochemic laboratories of the Department of Agriculture and the demonstrations which are possible in the Army Medical Museum and the Museum of Hygiene. He stated that the advantages for securing a thorough training in preventive medicine and in the study of tropical diseases are unexcelled anywhere, and predicted a useful future for the school, in the training of men who desire to become health officers, medical officers of the army, navy, marine hospital or the colonial service.

Dr. Needham welcomed the school among the educational institutions, and expressed satisfaction that the leading medical schools of the city had united in placing their laboratory and teaching facilities at the disposal of the graduate school, thus insuring a hearty cooperation in the promotion of higher medical education.

General Sternberg, the president of the faculty, in behalf of the school, returned thanks to the medical departments of Columbian and Georgetown universities and all hospitals in the city, government, private and municipal, for their

generous offer in placing their facilities at the disposal of the graduate school; he emphasized the clinical advantages, which are unusually great in proportion to the population, on account of the several large government institutions aggregating over 4,000 beds, with an excellent corps of teachers. The president then delivered his introductory lecture on 'Preventive Medicine,' tracing the progress and achievements of hygiene and the methods by which the beneficial results have been accomplished. The teaching staff of the school consists of 85 professors and adjunct professors. Clinics every day from 9 A.M to 2 P.M. Laboratory work every week day from 2 to 5 at the School of Medicine, Georgetown University, 920 H Street.

The following constitute the board of directors of the Graduate Medical School: General George M. Sternberg, U.S.A., President (address, 2144 California Ave.); J. Ford Thompson, Vice-President; George M. Kober, Secretary and Treasurer; Walter Wyman, Surgeon-General, Public Health and Marine Hospital Service; P. M. Rixey, Surgeon General U. S. Navy; R. M. O'Reilly, Surgeon General U. S. Army; A. B. Richardson, Superintendent Government Hospital for Insane; Samuel S. Adams, M.D., Swan M. Burnett, M.D., Joseph Taber Johnson, M.D., Sterling Ruffin, M.D., Edward A. Balloch, M.D., E. A. de Schweinitz, M.D., H. L. E. Johnson, M.D., William C. Woodward, M.D.

From the foregoing it would appear that here we have the foundation for the establishment of a school of preventive medicine, a most worthy undertaking, and the important question arises how many of our young medical men will avail themselves of this opportunity, especially when the average graduate may reason that he has devoted his time, money and energy to equip himself for the recognition and cure of diseases, and who will pay him for their prevention? It is evident that so long as no special qualifications are demanded for the appointment of health officers in the United States, a voluntary training in preventive medicine will be sought by a comparatively limited number, and yet the undertaking is of such far-reaching importance to the general public, that the establishment of fellowships in this school appears urgently called for. We know of no branch of science which has contributed so much during the past twenty-five years to the sum total of human happiness than sanitary science, and perhaps no field affords better prospects for fruitful results than the endowment of a school of preventive medicine.

SCIENTIFIC BOOKS.

Postelsia: The Year Book of the Minnesota Seaside Station, 1901. St. Paul, Minnesota. 1902. Small 8vo. Pp. 229.

This unique book is one outgrowth of the work done at the Vancouver Seaside Station of the University of Minnesota in the summer of 1901. It consists of seven papers which were given before the members of the station, covering the following subjects: 'Uses of Marine Algæ in Japan,' 'The Distribution of Plants in Colorado,' 'The Phylogeny of the Cotyledon,' 'Botanizing in Jamaica,' Algæ Collecting in the Hawaiian Islands,' 'The Distribution of Marine Algæ in Japan,' and 'The Kelps of Juan de Fuca.' These are illustrated by twenty-nine plates, three of which are reproductions of Japanese pictures showing the methods of collecting and preparing certain seaweeds for food.

It is difficult to decide which are the more interesting of these papers. One becomes greatly interested in the account given by Mr. Yendo of the uses to which marine algæ are put in Japan, and can not close the book until he has finished the paper. Then should he happen to open the book where Miss Butler describes her experience in Jamaica, he is charmed with the style of the enthusiastic

writer, who is an acute botanist as well; but just as he concludes these interesting pages he comes upon Miss Tilden's paper on botanizing in the Hawaiian Islands, and is fascinated again. So it is with all the articles. There is not a dull paper in the seven, and the editor is to be congratulated upon his skilful selection. He has achieved something literary in this volume, while at the same time adding not a little to our botanical knowledge. It is one of the very few botanical books which possess a distinctly literary flavor, and for this reason, in addition to its botanical merits, it is to be highly commended.

CHARLES E. BESSEY.
THE UNIVERSITY OF NEBRASKA.

SOCIETIES AND ACADEMIES.

BIOLOGICAL SOCIETY OF WASHINGTON.

THE 364th meeting was held Saturday, January 10.

Walter H. Evans stated that a bill had just been passed making a forest reserve of that portion of Porto Rico containing the only tract of primitive forest now remaining on the island.

Mr. L. O. Howard exhibited a series of lantern slides giving a pictorial history of the recent investigation of the etiology of yellow fever by the Army Yellow Fever Commission and the subsequent Board of Health of Havana. The slides included photographs of Major Reed, Drs. Carroll, Lazier and Agramonte, Dr. Carlos Finley, and Dr. Guiteras, as well as of Camp Lazier, the Las Animas Hospital and laboratories, and a number of others. He spoke eulogistically of the work of the commission and dwelt on the enormous value to humanity of the results of their work. He referred to the deaths of Drs. Reed and Lazier, and mentioned the memorial raised to the latter, and that now in progress for the former, as deserving in the highest degree of contributions from all scientific men. He also stated that in honoring the immortal dead we must not forget the living, and reminded the society that Dr. James Carroll, one of the society's members, was a member of the commission and in the thick of the struggle had been attacked with yellow fever but fortunately had recovered, and that he should receive the highest honor for the rest of his life.

S. F. Meek spoke on 'The Geographic Distribution of the Fresh-water Fishes of Mexico,' illustrating his remarks with lantern slides. He stated that four distinct fish faunas were represented in Mexico—that of the Rio Grande, with 80 species; the Colorado, with 9 species in western Sonora; the Lerna basin, with 49 species; and a tropical fauna with 137 species. The fauna of the Lerna basin was the most remarkable, for of the 49 species not one was found in any other river, while 9 of the 18 genera were peculiar to this basin. Sixteen of the species belong to the salt-water family Atherinidæ, and were the only salt-water fishes represented on the Mexican plateau. Seventeen species, including one *Gambusia,* belong to the Pœcilidæ, and all are viviparous. With the exception of the *Gambusia* these have the first six rays of the anal fin short and stiff, and having the same position in the males and females, while the viviparous Pœcilidæ previously known have the anal fin slender and placed well forward. The speaker noted that the tropical fishes extended northwards in a belt on the east and west coasts, reaching the highest latitude on the east. On the west coast the Cichlids extend to Mazatlan, and the Characins reach only to the Balsas, while on the east coast the Characins are the most northerly. He was of the opinion that the fish fauna of the Rio Grande region was derived from the Mississippi Valley, and that of Sonora from the Colorado. As for the Lerna region he believed that it was an island with a well-established fauna before a rise of the continent made it part of the mainland, and that it has since been a center of distribution.

O. P. Jenkins discussed 'The Rate of the Nervous Impulses in Certain Invertebrates,' saying that so recently as fifty years ago the most diverse opinions prevailed regarding the speed of nervous impulses, and that it had even been thought to exceed the speed of light. The experiments of Helmholtz showed that the rate was comparatively slow, being in the frog but ninety feet a second. Mr. Jenkins then detailed his own experiments

with various invertebrates, saying that he had found the lowest rate, 44 cm. per second, in a species of *Limax*, and the highest, 424 cm. per second in a squid; this rate was subject to very considerable individual variation.

Incidentally he noted that the collection of marine invertebrates showed a large number of new species of marine worms, and that the coast of California would probably prove a good collecting ground. F. A. Lucas.

MEETING OF THE SAN FRANCISCO SECTION OF THE AMERICAN MATHEMATICAL SOCIETY.

A regular meeting of the San Francisco Section of the American Mathematical Society was held at the University of California on December 20, 1902. Sixteen members of the society were present. By an amendment of the by-laws the name of section was changed from Pacific to San Francisco. The following papers were read:

Professor R. E. Allardice: 'On a system of similar conics through three points and its transformation group.'

Professor H. F. Blichfeldt: 'On a property of conic sections.'

Professor L. E. Dickson: 'Generational relations for the abstract group G simply isomorphic with the linear fractional group in the Galois field of order p^n.'

Professor L. M. Hoskins: 'A simple method of determining the free nutation of a yielding spheroid.'

Dr. D. N. Lehmer: 'On the parametric representation of the tetrahedroid surface.'

Professor A. O. Leuschner: 'Elimination of aberration and parallax in calculating preliminary orbits.'

Mr. W. A. Manning: 'The positive primitive substitution groups of class $2p$, p being any prime.'

Professor G. A. Miller: 'On the holomorph of a cyclic group.'

Dr. C. A. Noble: 'A problem in relative minima.'

Dr. S. D. Townley: 'The probability of collisions amongst the stars.'

Professor E. J. Wilczynski: 'On a certain congruence associated with a given ruled surface.'

The paper by Professor Dickson was presented by the secretary. In the absence of Professor Leuschner his paper was read by title. The other papers were presented by their authors. The next meeting of the section will be held at Stanford University in May, 1903. G. A. Miller,
Secretary.

CORNELL SECTION OF THE AMERICAN CHEMICAL SOCIETY.

The Cornell Section of the American Chemical Society was organized in December last, and has now received its charter from the national organization. The territory embraced by the section is that lying within a radius of ten miles from Cornell University, Ithaca, N. Y., with headquarters at the university. At the time of organization there were twenty-four members of the American Chemical Society who became charter members of the Cornell section. Since then the membership has increased to forty-four.

The officers for the current year are:

President—Professor L. M. Dennis.
Vice-President—Professor W. D. Bancroft.
Secretary-Treasurer—Mr. W. C. Geer.
Executive Committee—Messrs. Dennis, Bancroft and Geer, *ex officio*, Professor W. R. Orndorff, Mr. J. E. Teeple and Mr. J. G. O'Neill.
Councilor from Cornell Section—L. M. Dennis.
Councilor ex officio—G. C. Caldwell.

The meetings of the section are to be held monthly in Morse Hall, Cornell University. The evenings will be occupied largely with original papers read by members of the society, but it is planned to vary the meetings with occasional lectures or addresses by men well known for work in special fields. Thus in the course of the year there will be interspersed with the original papers, addresses on subjects of technical importance and on the more chemical phases of allied sciences. By this means the society will conserve all the fundamental aims of the American Chemical Society, as well as aid in broadening the horizon of the members of the section by keeping them in touch with the progress of those sciences which so frequently extend into the fields of chemical research.

The first meeting was held on the evening of December 15. Papers which presented the results of original work done in the chemical department were read and discussed. Mr. E. S. Shepherd read a paper on the

'Alloys of Lead, Tin and Bismuth'; Mr. G. H. Burrows, on 'Reduction with Soluble Anodes'; and Mr. J. G. O'Neill on 'The Determination of the Benzene in Illuminating Gas.'

At the second meeting, which was held on the evening of January 12, the section was addressed by Professor W. D. Bancroft, on the 'Theory of Indicators.' The lecturer illustrated his remarks by many experiments which were explained on the basis of the theory of electrolytic dissociation.

The favorable auspices under which the Cornell Section begins existence seems to augur for it a highly successful future.

W. C. GEER,
Secretary.

ELISHA MITCHELL SCIENTIFIC SOCIETY.

THE 144th meeting was held in Person Hall, University of North Carolina, Tuesday, December 9, at 7:30 P.M.

The secretary called attention to the importance of the coming Washington meeting of the American Association.

Professor J. W. Gore spoke of his experiments on 'Wireless Transmission of Electrical Energy.'

Mr. Gore called attention to the fact that an ordinary telegraphic current will cause a coherer to respond when the antenna is near and placed in any position relative to the current. When at right angles, this effect cannot be due to the cutting of the antenna by magnetic lines of force from the current. It is to be inferred that electrostatic induction causes the action of the coherer, just as is the case when the antenna is near an open circuit connected to a terminal of an induction coil, or near an insulated conductor whose potential is suddenly changed.

It was stated that possibly wireless transmission of energy is due to the propagation of waves started by oscillatory electrostatic stresses between earth (conductor) affected ether and the ether some distance above the earth.

Mr. R. O. E. Davis, in a paper on 'Improvement in Method of Halogen Determination,' presented the results by Professor Baskerville and himself in their efforts to obtain a more satisfactory method for the determination of chlorine in their work on the atomic weight of thorium. Abstract of his paper has been printed in the *Proceedings* of the North Carolina Section of the American Chemical Society.

Mr. G. N. Coffey, of the United States Soil Survey, gave an interesting account of its work in the field and laboratory, and the benefits to be derived therefrom.

CHAS. BASKERVILLE,
Secretary.

COLUMBIA UNIVERSITY GEOLOGICAL JOURNAL CLUB.

January 9.—Dr. A. A. Julien reviewed 'Recherches Geologiques et Petrographiques sur L'oural du nord,' par Louis Duparg. Among the new rocks noted was koswite, which is composed of olovine and pyroxene cemented together by magnetite. Dunite also occurs there in great continuous sheets, with its individual grains much larger than that from North Carolina.

January 16.—Professor Kemp gave a talk upon some large specimens of covellite which he had just received from Butte, Mont.; also upon some native gold in a quartz vein from the North Star Gold Mines, Grass Valley, Cal. This latter was obtained at a vertical depth of about 2,000 feet. He also showed and commented favorably upon Professor J. C. Branner's 'Syllabus of a Course of Lectures on Elementary Geology.' Mr. G. I. Finlay discusred the method of recalculation of chemical analyses as applied to the new system of classification of igneous rocks.

January 23.—Professor Kemp showed some platinum nuggets from British Columbia, some large specimens of ruby silver ore from Chili, and rich copper ore from Summerville, N. J. Mr. G. I. Finlay then continued from the previous week his discussion of the new classification of igneous rocks. Professor Kemp will take up the discussion next week.

H. W. SHIMER.

DISCUSSION AND CORRESPONDENCE.

THE USE OF THE WORD GEEST IN GEOLOGY.

To the Editor of Science: The *American Geologist* for December, 1902, reprints an extract from the 11th Annual Report U. S. Geological Survey, by W J McGee, upon the use of the term *geest* in geology. Dr. McGee calls attention to the fact that there is no general term in common use to designate the undisturbed products of weathering, and proposes the Dutch word *geest,* as used by De Luc, Eaton and Beck, to distinguish such material *in situ* from *alluvium* or transported material. Dr. McGee overlooks the fact that *geest* and *alluvium* are themselves specific terms denoting members of a class, while for the class itself a common descriptive or 'denotative' term is still wanting. In his first sentence he introduces his subject as 'the superficial mantle of rock débris.' Later it appears as 'the extensive mantle,' etc., and 'the unconsolidated materials by which these [solid] rocks are mantled.' Every recent writer upon geology and physical geography has had to wrestle with this problem and has usually solved it by some circumlocution. The older writers, Lyell, Dana, Prestwich, Geikie, Le Conte and even Scott use only the term *soil,* and appear to do so without any sense of unfitness or inadequacy. Brigham ('Text-book of Geology') discusses 'the whole sheet of crumbled rock material which mantles most of the rocky foundation of the lands,' but finds no better term for it than 'this mantle.' Elsewhere he uses 'rocky débris' and 'land waste.' Gilbert and Brigham ('Introduction to Physical Geography') use several variations of the theme, 'earthy mantle that covers the rock,' 'waste cover,' 'earthy cover,' 'waste mantle.' They state explicitly: 'The student should distinguish clearly and use it [soil] only of the veneer of earthy matter which is especially fitted to support life.' Davis ('Physical Geography') commonly uses *waste* with various modifiers, as 'rock waste,' 'land waste,' 'sheet of loosened rock waste,' 'cloak of rock waste,' 'waste sheet.' In the *Journal of Geology,* Vol. 10, p. 98 ff., he uses many times the phrases 'sheet of waste' and 'cloak of waste.' Merrill ('Rocks, Rock Weathering and Soils') strikes out boldly and manufactures a new term, *regolith,* blanket rock for the 'entire mantle of unconsolidated material, whatever its nature or origin.' For non-classical students I have translated regolith into *mantle rock,* and have used that term for several years with perfect satisfaction. The above quotations show how difficult it is to avoid some term expressive of the idea of a cover or mantle. *Waste* is open to the objection that it expresses a half truth in such a way as to give a false impression. It is waste only in relation to its past. In its destination and future functions it is not waste, but 'the dust of continents to be.' It is always a mantle which covers some other kind of rock, and in geography the distinction between the mantle and that which it covers is more important than the distinctions between aqueous, igneous and metamorphic rocks. I suggest, then, the term *mantle rock* for the material which Merrill has named the regolith, and hope that it may find favor and supply a long-felt want. It is plain Saxon, expresses the most distinctive and striking character of the material, has no misleading implications and fits readily into any place where it is needed. I find in the note-books of my students such records as these: "Lawrence Co., bed-rock limestone, mantle red clay. Green Co., bed-rock shale, mantle glacial drift." To substitute waste, detritus, débris, geest, alluvium, unconsolidated materials, or any other term for *mantle* in these phrases would be distinctly no improvement.

Charles R. Dryer.

Terre Haute, Ind.

ATAVIC MUTATION.

To the Editor of Science: Dr. White's article on aggregative atavic mutation of the tomato, in Science for January 9 recalls to me a case of—apparently—similar atavic mutation, which Dr. White should be in a position to investigate, if, indeed, he has not already done so. When I lived in Washington, some ten years ago, we were rarely able to get any really *sweet* sweet corn, such as is so abundant here in New England. The

vegetable commonly found in the market was as tasteless as white field corn. The market people told us that to obtain sweet corn, it was necessary to plant northern seed every time, while the seed corn grown from northern seed always gave the tasteless variety.

Since, I believe, our sweet varieties of corn are derived by cultivation from the white field corn, this looks very like a case of atavic mutation. I hope that Dr. White or some other investigators in Washington may be able to give us further information about this matter.

JOHN MURDOCH.

PUBLIC LIBRARY, BOSTON, MASS.,
January 12, 1903.

NOTES ON INORGANIC CHEMISTRY.

DISCOVERY OF NEW PLATINUM DEPOSITS.

A NEW YORK *World* dispatch from St. Petersburg of the date January 18 announces the discovery of vast deposits of platinum on the river Gusseva. It is said that within a month 25,000 men swarmed to the diggings, and before the police could reach the camp the miners got away with $1,500,000 worth of platinum. The locality indicated in the dispatch is in the upper, or Goroblagodatsk district, on the eastern watershed of the Oural Mountains. The mines of this region are chiefly owned by Count Shouvalof and a number of companies. About eighty miles to the south is the Nizhni Tagilsk district, which is owned by the Demidoffs, and which has been the greatest producer of platinum in the past. The last few years the northern district has been a larger producer, but the sands and rock have run very low in platinum. While as recently as 1870 the richness of the sands was as high as one ounce to the ton, in 1895 the average was hardly one and a half pennyweights to the ton. The total production of that year was less than 150,000 ounces. If the figures of the *World* dispatch are reliable, it would indicate the production in a month of more than the usual annual output of late years. The platinum problem has become a very serious one, for while the demand has increased rapidly the last few years, the supply has been diminishing. Great efforts have been made to discover new fields, but without much practical success. Platinum occurs in many places, but generally in insufficient quantities to pay for working. The Goroblagodatsk district consists chiefly of the river Iss and its tributaries. The total length of these streams is about sixty miles, and the Gusseva is one of these affluents. Allowing for all the probable exaggeration of the dispatch, it would seem that deposits have been discovered in this region which must be far richer than any which have been worked for many years. It is sincerely to be hoped that they shall prove to be of considerable area.

J. L. H.

CURRENT NOTES ON METEOROLOGY.

REPORT OF THE CHIEF OF THE WEATHER BUREAU.

THE 'Report of the Chief of the Weather Bureau' for 1901–1902 (4to, pp. 342) contains a number of interesting facts regarding the work of the Bureau. The storm warnings issued for the transatlantic steamship routes were so successful that the secretary of 'Lloyd's,' in London, conveyed to the Chief of the Bureau the congratulations of his committee 'on the infallibility of the predictions that have been supplied by the forecasts.' On August 1, 1902, 10,025 rural free mail-delivery routes were in operation, serving approximately 1,000,000 families. Of these families, 105,000, served by about 1,000 routes, were furnished with the forecasts of the Weather Bureau. If the necessary funds were available, it would be possible to make the distribution of the daily forecasts coextensive with the rural free delivery itself. Professor Abbe has acted as the general adviser of the trustees of the Carnegie Institution on matters pertaining to meteorology, and has also been charged with the oversight of the aerial research work of the Weather Bureau. A valuable set of nephoscope observations from the West Indies has been secured, from May, 1899, to May, 1902. Among the special studies carried on by the Bureau are the following: Investigation of the intensity of solar radiation by means of Angström's electric compensation pyrheliometer; a new barometric

system for the United States, Canada and the West Indies; a discussion of the vapor tension observations throughout the United States; a study of wind velocities and fluctuations of water level on Lake Erie, and of eclipse meteorology and allied problems.

The 'Report' also contains, besides the usual tables, tables showing the highest and lowest temperatures recorded at Weather Bureau stations for each month of the year, from the beginning of observations until the end of 1901 (with charts); the monthly and annual mean relative humidity for all Weather Bureau stations (with charts), etc.

SIMILAR BAROMETRIC VARIATIONS OVER LARGE AREAS.

Sir Norman Lockyer and Dr. W. J. S. Lockyer, in England, and Professor F. H. Bigelow, in this country, have lately been investigating the similarity of curves representing many solar and meteorological phenomena. Several papers on this subject have already been published. In *Nature* for January 8, Dr. Lockyer presents some of his latest results. The curves showing the variations in pressure at Bombay, Colombo, Batavia, Mauritius, and Perth Adelaide and Sydney, Australia, are strikingly similar and indicate that the same kind of variations are in action over the whole region. The curves for Cordoba, Mobile, Jacksonville, Pensacola and San Diego, and the *inverted* curve for Bombay are also very similar to one another. Here, then, are two large areas indicating similar barometric variations from year to year, but one showing an excess while the other displays a deficiency. Professor Bigelow has also come to the conclusion (*Monthly Weather Review*, XXX., 347) that the same pressure variations prevail over very large areas, but that they vary from one district to another. Dr. Lockyer points out that the two investigations agree as to the following points: (1) The close connection between solar activity and barometric pressure; (2) the great extent over which very similar pressure variations exist, and (3) the presence of two large areas, the pressure variations over which are the reciprocal of each other.

WINTER ARIDITY INDOORS.

The dryness of the air in furnace-heated houses is attracting more and more attention. In Science for March 23, 1900 (N. S., Vol. XI., 474), reference was made in these Notes to some observations of relative humidity made by the undersigned in his study during three weeks of November, 1899. In the *Journal of Geography* for December last, Professor Mark S. W. Jefferson, under the title 'Winter Aridity Indoors,' presents a simple mathematical treatment to show the actual quantities of water demanded in connection with a heating and ventilating plant to preserve a healthful humidity within doors in winter. Professor Jefferson concludes that, under the average conditions of temperature and humidity indoors during the three weeks referred to above, about two gallons of water per individual should be evaporated to humidify the daily supply of air. Such observations as these naturally suggest a useful line of work in connection with giving the air from our furnaces a proper supply of moisture.

NOTES.

The rapid advance of balloon and of kite meteorology is evidenced by the fact that a new meteorological station has been established at Viborg, in northern Jutland, for the express purpose of carrying on the investigation of the free air by means of kites and balloons. This station is maintained through the cooperation of French, Swedish and Danish meteorologists. The location is an admirable one, being in a district where storms are frequent. Twenty-eight persons constitute the force at the new observatory, in whose establishment Messrs. de Bort, Hildebrandsson and Paulsen have been chiefly concerned.

R. DeC. Ward.

ELECTRICALLY UTILIZED POWER AT NIAGARA FALLS.

Recent Consular Reports include one from Consul H. W. Brush, at Niagara Falls, Ontario, Canada, on the development of hydraulic power from the great falls. The original development of 50,000 horse-power on

the American side is now to be supplemented by an equal amount, the constructions for which are well under way. It is expected that about 50,000 horse-power will become available on the Canadian side toward the end of the coming summer, and contracts already signed contemplate a total of not less than 110,000 horse-power in units of 10,000 horse-power each, double the first unit, then considered a tremendous experiment. A new company, the Ontario Power Company, on the Canadian side, contemplates a plant to deliver 50,000 horse-power at the start and 150,000 ultimately. This, like the original corporations on both sides the gorge, is largely backed by capital from the United States. A new company will probably be presently authorized by the Canadian government, which will presumably, at the start at least, be wholly Canadian. This will mean the further development of 100,000 horse-power. About 350,000 horse-power may thus be expected to be soon supplied, and it is computed that it will result in the influx of about $7,000,000 annually as rental. Within ten years, it is prophesied that a million of horse-power at least will be developed at Niagara Falls.

Efforts have been made to observe the effect of the present maximum draught of water from the falls; but the most careful measurements and observations are reported to have failed in indicating, much less measuring, any effect when the power is turned on and off. The effect of a wind blowing up or down channel is, on the other hand, very observable, and a heavy blow may alter the level of the water at the entrance to the Niagara River and at the head of the rapids by several feet; but its effect at the falls is too slight to be readily observed, except by those who are familiar with the river in all its aspects.

The horse-power of Niagara is a somewhat uncertain quantity, and is variable with every wind and with every change of season. The first survey, made with the object of measurement of the power available at the falls, was, if the writer is not misinformed, that of Mr. L. M. Wright, a quarter of a century ago, or more, who employed the famous ferryboat, *Maid of the Mist*, driving her stem up under the cataract as closely as the swift current would allow, and securing measurements of rate of flow at that and other cross-sections of the river. He allowed the writer to make extracts from his notes at the time.

He found the section thirty yards below Chippewa Creek to measure 6,667 feet across, with a depth of 15 feet. He estimated the minimum power of the total fall as 11,363,636 horse-power, and the maximum as a third greater; the variation being due to the action of the winds on the Great Lakes. These figures are probably too great. A number of estimates have been since published, usually much less. The Lake Survey gave, for example, as reported, about 280,000 cubic feet, per second, as the flow at the falls; while the pioneer observer gave 500,000. Taking the two as extremes, it is perhaps safe to assert that the extinction of the falls, either by diversion into industrial power or by their cutting back to the upper lake, may be expected to be not likely to prove a burning question with this generation.

And yet, with a third of a million horse-power already practically preëmpted, with our forests disappearing, with a corner in the coal market already, and other strikes to come, and with the brink of the falls retreating with accelerated rapidity, it is possibly unwise to bank heavily upon that expectation. But, however this may be, the Falls of Niagara will surrender hundreds of thousands of horse-power in the current decade, and all this power will be distributed electrically and much of it employed in electrical processes of manufacture.

R. H. T.

SCIENTIFIC NOTES AND NEWS.

THE Desmazières prize of the Paris Academy of Sciences has been awarded to Professor Roland Thaxter, of Harvard University, for his study on the parasitic fungi of American insects.

THE Carnegie Institution has appropriated $4,000 to the Yerkes Observatory, to be expended under the direction of Professor George E. Hale, for certain researches in astronomy

and astrophysics. These will comprise: (1) A photographic investigation of stellar parallaxes by Dr. Frank Schlesinger, now in charge of the International Latitude Observatory at Ukiah, California. (2) Investigations in stellar photometry, to be made by Mr. J. A. Parkhurst. (3) A detailed study of several hundred photographs of the sun, taken with the spectroheliograph at the Kenwood Observatory in the years 1891–1896. Mr. Philip Fox, formerly instructor in physics at Dartmouth College, is assisting Professor Hale in this work. (4) Certain investigations in solar and stellar spectroscopy, to be undertaken by Professor Hale as soon as the new horizontal reflecting telescope, recently injured by fire, has been completed.

Professor Frederick W. Putnam, curator of the Peabody Museum, has been awarded the Lucy Wharton Drexel medal of the Franklin Institute of Philadelphia for his distinguished work in American archeology.

Commander Robert E. Peary, U.S.N., was elected president of the American Geographical Society, New York, at its annual meeting on January 27.

Professor E. B. Wilson, of Columbia University, has received leave of absence for the second half year, and will be at the Naples Zoological Station from February until July. During his absence the direction of the Department of Zoology at the university will be assumed by Professor Bashford Dean, to whom communications for the department should be addressed.

Dr. J. F. Newsom, associate professor of mining and metallurgy in Stanford University, has returned from a visit to the principal European schools of mining.

President H. S. Pritchett, of the Massachusetts Institute of Technology, is confined to the house by an injured knee, due to the fall of a horse that he was riding.

National Geographic Magazine (Washington) for February is authorized by Mr. William Ziegler, of New York City, to announce that he intends to send forth another north polar expedition this summer. The party will go north on the *America*. The personnel of the expedition is not yet complete, so that a list of the members can not now be given.

Mr. W. N. MacMillan, of St. Louis, with Mr. Isidore Morse, of Boston, and Colonel John Harrington, of the British Army, have started on an expedition to explore the course of the Blue Nile.

Professor R. H. Richards, of the Massachusetts Institute of Technology, has just completed a short course of lectures on ore-dressing, in which he set forth the results of his exhaustive study on this subject, at the Missouri School of Mines at Rolla, Mo.

Mr. Charles Francis Pidgin, chief clerk of the Massachusetts Bureau of Statistics, has been appointed chief of the bureau, to succeed Mr. Horace G. Wadlin, who has become librarian of the Boston Public Library.

Dr. Brouardel, honorary dean of the Paris Faculty of Medicine, has been presented with a plaque by his former students, engraved by M. Roty.

M. H. Poincaré, the eminent mathematician and physicist, has been made a commander of the Legion d' honneur.

Professor Robert Helmert, director of the Geodetic Institute of Potsdam, has been given the honorary doctorate of engineering by the Polytechnic School at Aix.

Mr. Herbert Kynaston has been appointed by the British Colonial Office director of the Geological Survey of the Transvaal.

The hundredth anniversary of the birth of Heinrich Daniel Rhumkorff was celebrated at Hanover on January 15. A tablet was placed on the house in which he was born and a new street was given his name. Professor W. Kohlrausch made an address on Rhumkorff's scientific work.

David Phillips Jones, chief engineer, U.S.N. retired, and formerly professor at the Naval Academy, died at Pittsburgh on January 30.

Mr. Elnathan Sweet, a well-known civil engineer, died at Albany, N. Y., on January 26, aged sixty-six years.

Dr. John O. Quantz, professor of psychology in the State Normal School of Oshkosh,

Wisconsin, died of heart trouble on Saturday, January 24. He was called to the position at Oshkosh about a year and a half ago. He was an able and accomplished scholar and an educator of great promise. His brilliant mind and scholarly achievements three times secured for him recognition in the way of fellowships from three American universities. For two years after graduating as honor man at Toronto he was fellow in psychology in the University of Wisconsin, which institution bestowed upon him the degree of doctor of philosophy in 1897. Clark University, Worcester, Massachusetts, then honored him with a fellowship for a year, and Cornell for the year following. He was born near Toronto, Canada, about thirty-five years ago. In his professional career he had gained a large circle of admiring and steadfast friends. T. L. B.

THE cablegram from Edinburgh which we quoted last week to the effect that Mr. Andrew Carnegie would establish with $5,000,000 an endowment for scientific research in Scotland is said to be without foundation. Under these circumstances we almost hesitate to quote the item in the daily papers this week to the effect that Mr. John D. Rockefeller will give $7,000,000 for the erection and endowment of a research hospital in connection with the Medical Department of the University of Chicago.

WE are sometimes compelled to quote from the daily papers announcements of gifts and endowments without assurance of their correctness, but we refrain from quoting medical discoveries, otherwise it would be necessary to announce cures for blood poisoning, hay fever and pneumonia, and the discovery of the bacillus of hydrophobia. The name given to the alleged bacillus of the latter disease reads as though it might be correct 'Coccus babyllus polymorphus lissac.'

Nature quotes from a German newspaper an item to the effect that Dr. Dohrn, of Naples, having appealed with little result to the German minister of education for financial aid in the extension of his world-famed biological station, sought an interview with the Kaiser. Remarking sympathetically that he could not provide all that Dr. Dohrn desired from his private purse, the Kaiser furnished him with a donation form, headed by himself and a contribution of £1000 commanding that it should be circulated among the leaders in Berlin society, for return to the Kaiser in person. The result was that within a few days the magnificent sum of £15,000 was subscribed.

THE new lion house of the New York Zoological Park was opened on February 2. It is said to be the finest building for this purpose in existence. The main corridor is 192 feet long, some of the cages, which are enclosed by netting instead of iron bars, being as large as 18 x 22 feet. The building includes a studio for artists with a special cage.

THE daily papers state that the University of Chicago has received from Sir William Van Horne of Montreal a collection of fossils valued at $30,000.

A LARGE collection of sea anemones from the coast of Chili has been examined for the Royal Museum of Berlin by Dr. J. Playfair McMurrich, professor of anatomy in the University of Michigan. Dr. McMurrich's report will be published in a future number of the *Zoologische Jahrbucher*.

ENGLISH papers state that Sir Ernest Cassel has offered to give £40,000 towards the study and investigation of ophthalmia in Egypt.

THE board of directors of the American Institute of Electrical Engineers has passed a resolution disapproving of the establishment on the part of N. Y. state of an electrical laboratory and standardization bureau.

TELEPHONIC communication has been established between Paris and Rome, which is the longest line in Europe, though it is surpassed in America. The distance from Paris to Rome is 1,593 km. and from Paris to Berlin 1,115 km.

UNIVERSITY AND EDUCATIONAL NEWS.

HARVARD UNIVERSITY receives $50,000 by the will of Rebecca C. Ames, the income to be used for the support of poor students.

The annual report of Provost Harrison shows that the University of Pennsylvania has received gifts during the year to the value of $936,851, and that the total value of gifts since 1895, when Dr. Harrison became provost, is $4,750,161.

A bill has been introduced in the senate of the state of California providing for a special procedure in court to confirm the legality of trusts for eleemosynary and educational institutions. It is understood that the bill has been introduced to enable Mrs. Stanford to divest herself of the control of the property left by her husband for Stanford University.

The Military Academy appropriation bill, carrying $644,273, was read and passed in the Senate on January 27, without amendment or debate.

The Thaw fellowship in astronomy in Princeton University is open for next year to a college graduate of not more than five years' standing. Inquiries may be addressed to the professor of astronomy or to the university registrar. Applications with proper credentials must be filed with the registrar before May 1.

The board of trustees of the New Mexico School of Mines has established a system of fellowships and scholarships in mining and geology. The first group will include ordinary fellowships, which are expected to yield $300 a year; and traveling fellowships, which are expected to yield annually $500 and $1,000. The scholarships are available this year. There are fifty scholarships, each yielding $100, open to students living in the United States. There is one scholarship for each state in the Union. The student from each state passing the best examination for entrance to the school, or to advanced standing, or furnishing evidence of best qualifications to carry on the work in this institution, is awarded the scholarship for that state. There are forty scholarships each yielding $25 a year, and open to students who are actually residents of New Mexico. They are good for one year; and are bestowed at the beginning of each academic year. These scholarships are awarded annually as honors. The main object sought in the bestowal of these honors is the encouragement of scholarship among those who wish to prosecute studies related to mining in the New Mexico School of Mines.

Early on Sunday morning, January 25, the College Chapel at Oberlin was completely destroyed by fire. It was the oldest building in use by the college and was built in 1854. The offices of the president, treasurer, secretary and registrar and the Y. M. C. A. reading room were on the first floor. The records and nearly all valuable papers were saved. The Old First Church will be used for chapel purposes, and the administration offices will be located in the power house until a new chapel and a new administration building can be provided. The insurance was only twenty thousand dollars.

The fifty-second anniversary of founder's day at Northwestern University was celebrated on January 28, when the new professional school building was dedicated. President Hadley delivered an address on 'The Place of the Professional School in the Modern American University.'

Dr. William E. Huntington, professor of ethics and history and dean of the College of Liberal Arts of Boston University, has been appointed acting president of the institution. A committee of the trustees has been appointed to recommend a successor to the Rev. William F. Warren. Dr. Warren has been guaranteed a salary of $2,500 during life and the chair he occupies in the school of theology has been given his name.

At Stanford University Edward C. Franklin has been appointed an associate professor in the department of chemistry, to succeed the late Professor George M. Richardson.

Dr. Oliver Dimon Kellogg has been appointed instructor in mathematics at Princeton University.

Dr. Th. Descoudres, associate professor of theoretical physics at Wurzburg, has been called to Leipzig.